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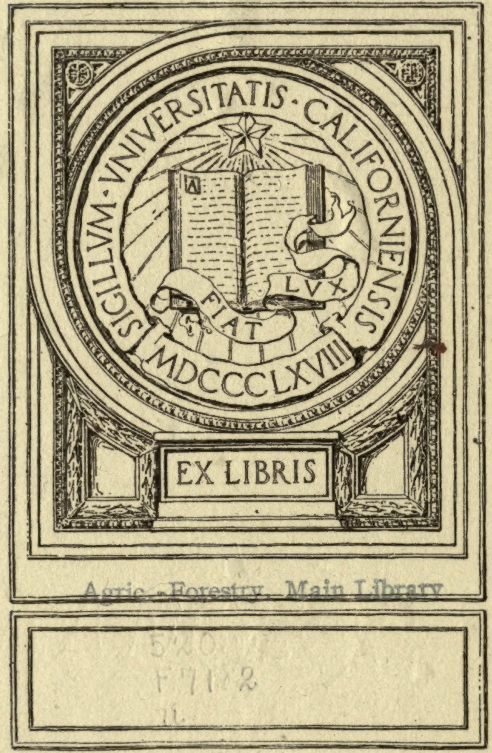

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Teachers Cottages

BY

R. S. KELLOGG

(In cooperation with the U. S. Bureau of Education)

UNIV. OF
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TEACHERS' COTTAGES.

THE PROBLEM IN RURAL EDUCATION.

The Superintendent of Public Instruction of the state of Washington, Mrs. Josephine Corliss Preston, states a vital problem in a few words, when she says:

> "The greatest problem in education today is the rural school. The greatest need is for teachers with initiative, leadership, experience, high ideas, character, broad sympathy and education. Where shall we get them?"

There are more than 200,000 rural school districts in the United States, and over 16,000,000 children of school age who either live in the country or in towns of less than 2,500 population. In a large number of these districts it is absolutely impossible to get and keep teachers of the character so well stated by Mrs. Preston. Practically one-third of the rural teachers in the United States have had no professional preparation for their work. An examination of the conditions quickly shows the reasons for the acknowledged failure of rural education to keep pace with the progress in city schools.

In the usual country school district, no residence is supposed to be beyond walking distance from the schoolhouse. However, it is very largely a matter of chance as to whether any of the scattered farm houses are close enough to the school to be convenient for the teacher, and a still greater matter of chance as to whether a farm house so located has room enough to take care of a teacher, or occupants who desire a boarder. Many farm houses have no accommodations whatever for a teacher, and often kitchen, living room, and dining-room are combined in one, with no heat in any other room in the house. The farmer and his family have to spend most of their time working indoors or out, eating and sleeping. Their occupations and hours of labor in no way correspond to those of the teacher, which increases the difficulty of fitting the teacher's necessary habits to those of the farmer with any satisfaction to either. A good teacher must spend a considerable amount of time almost every evening upon school work, for which a quiet, comfortable room is essential. If she insists upon such a room when she goes to board in the country she is likely to be considered "stuck-up" and exclusive. If she gets a room by herself it is often unheated and too uncomfortable for study in cold weather. On the other hand, if she is forced to spend her entire time in the living room with the rest of the family she has no opportunity to prepare properly for her school duties, and is also very likely to be drawn unavoidably into neighborhood gossip and factional disputes, of which unfortunately there are altogether too many. Many of the better situated families in the country districts who have the facilities, do not care to take a steady boarder, so that if a teacher gets a place to board at all she may be forced to go to farm houses where only the barest accommodations can be secured.

Under these circumstances, the teaching of a country school often becomes simply a temporary expedient for the teacher the first term after getting a certificate, and ambitious teachers who are anxious to grow in their profession, and make something of themselves, go to the city schools just as soon as possible, where opportunities for learning are greater and living conditions better. The country schools are always left with the largest proportion of young, inexperienced, poorly trained teachers, or with teachers who have been content to go on year after year shifting from one district to another, without qualifying themselves for the more rigid requirements of the city schools. Out of 9,883 teachers in one and two-room rural schools in Missouri, in 1910-11, but 55 had taught six or more consecutive years in the same location. A teacher may continue for many years with the lowest grade of certificate in the country schools, but this cannot be done in the city schools. In the four states of South Dakota, Kansas, Texas and Wisconsin, there are over 18,000 rural teachers who have not had even a partial high school education.

The problem from the teacher's standpoint is well summed up by Miss Ellen G. Syse of the North Dakota Agricultural College, from whose manuscript, entitled ''The Teacher's Boarding Place and the Rural School,'' we quote as follows:

> "Much complaint is made of the inefficiency of the rural schools, and vigorous efforts have been exerted on every hand to build up a more effective and efficient rural school system. But in working out the problem, it has been approached, more or less, from the viewpoint of the needs of the community, and rarely, if ever, from the viewpoint of the needs of the teacher. We have sought to build up an efficient rural school system by making demands upon the teacher, defining her duties and determining her qualifications for service, forgetting that only when we create conditions that will attract the well-qualified teacher and justify her in remaining with us, shall we secure the service which makes for good rural schools.
>
> Well-qualified teachers will not stay in a place where boarding conditions are poor, at the worst they will stay only until they have attained the teaching experience required to qualify them for teaching in the village or city schools. Rarely, however, do they remain for more than one term in such a community. As a general rule, those communities providing congenial living conditions secure the good teachers, while those neglecting their teachers must take the less competent ones, making for less efficient work and ineffective schools.
>
> From a recent investigation in regard to North Dakota rural school conditions, it is evident that many of our rural communities are not aware of a close connection between good boarding places and good school teaching. Statements received from county superintendents and rural teachers of the state show that in a number of localities the living conditions pro-

> vided for the teacher are far from satisfactory, and that in many places they are so poor that the teachers are jeopardizing their health by staying."

The final result of this combination of circumstances is altogether unfair, since nearly 60 per cent of the children of school age in the United States are in the rural districts. In the city schools there is manual training for the boys, domestic science for the girls, laboratory equipment of many kinds, and the best teachers that can be secured. The ordinary country school has but little more equipment than it had 25 years ago, which makes it doubly important that the lack of equipment be compensated for by teachers with more attractive personality, better training, and greater resourcefulness. The disparity between the city schools and the country schools will continue to increase until some means is found to get and hold more experienced and better trained teachers in the country districts. Better teachers result in better school houses and equipment as is well stated by A. C. Monahan of the U. S. Bureau of Education:

> "It is true that a good school may exist in the poorest building and with the poorest equipment, but, as a rule, the condition of the building and equipment is a good indication of the instructional work of the school. In other words, instructional work of a high grade in a school reacts upon the material equipment for whether the good instruction is due directly to the teacher or indirectly to a good supervisor through her, its influence is sooner or later felt by the school directors and by the school patrons, and results in a general improvement of the material facilities. Investigation, as far as it has been carried out, seems to show that, as a rule, wherever the greatest advance has been made in rural schools, improved buildings and equipment have followed improved teaching."

How to secure better teachers is a problem in which every country tax payer is directly interested, as a simple matter of getting a full dollar's worth for his investment, and a problem in which everyone is concerned, because it involves the entire question of community development and better citizenship.

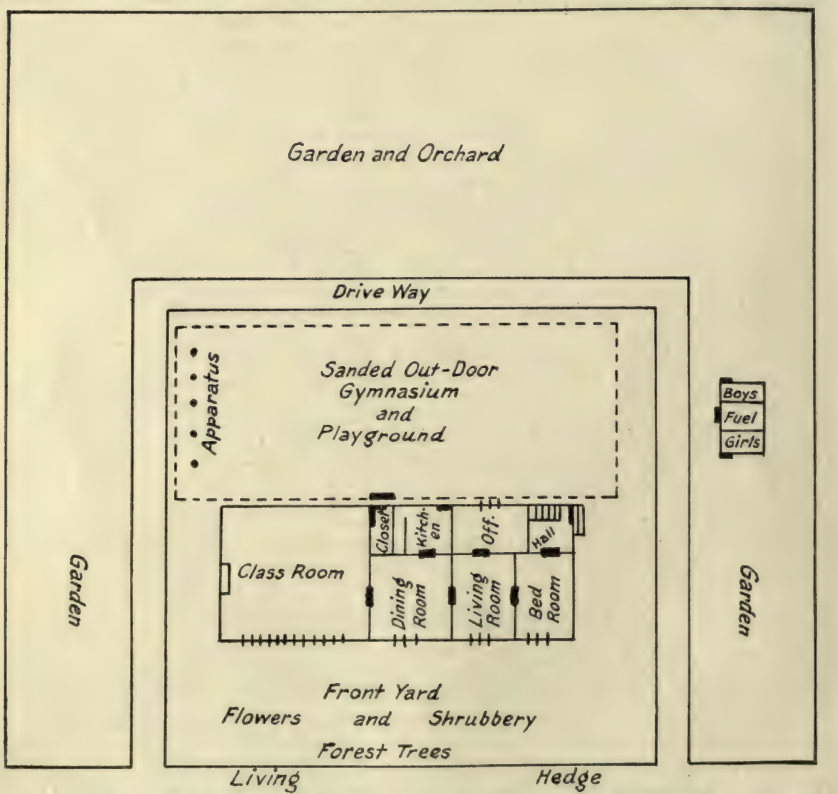
The state of Washington has taken the lead with a simple, practical solution of this problem—a solution which is so simple now that it has been found, it seems strange that it was not discovered long ago. This is

THE TEACHER'S COTTAGE.

The teacher's cottage, or "teacherage," is a permanent residence for the teacher, built near or in combination with the school house. It serves the same function that a parsonage does in connection with the church.

A few years ago an energetic young country school teacher in the state of Washington was utterly unable to find a family that would accept her as a boarder for the school term. Nothing daunted, she persuaded the authorities to move a portable cook house into the school yard. It was only 20 feet long and covered with canvas, but she partitioned it off with a curtain, furnished it, and put on ready-made roofing when the winter rains set in. Her younger brother, a twelve-year-old boy, stayed with her, and they lived in the cook shack the entire term. This example convinced the district authorities that they should provide a suitable dwelling place for the teacher, and the first teacher's cottage in the state of Washington was ready the following September, when it was occupied by the teacher and her mother. The same teacher stayed there three years, and finally left to complete her college course, but the teacher's cottage had proved its mission. The State Superintendent of Schools took up the question, the plan spread to other districts, and now the state of Washington has 108 of these cottages, which are found in 29 of the 39 counties in the state.

This apparently new idea in America is an old one elsewhere for it has long been the custom in England, the Scandinavian coun-



Layout of Typical Rural School Grounds in Denmark

(Courtesy of U. S. Bureau of Education)

tries, Germany, France, Denmark and Switzerland to furnish residences for the teachers, who are employed by the year, and often spend a lifetime in the same school.

In Denmark, for example, the law requires that all rural teachers be provided with free homes, which are kept up and heated at public expense. The United States Bureau of Education, Bulletin 1913, No. 58, "The Educational System of Rural Denmark," says:

> "Country teachers are all provided with free homes. These range from three-room suites in the case of unmarried women teachers to seven or eight rooms for married men. The suites are built, as a rule, in connection with the main school building, using either the second floor or a wing on the first floor. Where more than one teacher lives in the building each suite of rooms invariably has its own separate entrance. This system of teacher housing is very successful and means much for the teacher and for community leadership.
>
> Another thing of interest is that all teachers are entitled under the law to a garden. This is planned and planted to shrubbery and fruit at community expense. The garden may vary from a small lot to nearly an acre of ground. In a few instances women teachers accept a sum of money in lieu of the garden. Not alone do the gardens supplement the teachers' incomes, but they are often used as experimental plats for the schools as well.
>
> Such schools provided as they are for housing the teachers and making their lives attractive and wholesome, naturally become the rallying centers for all community activities."

A sketch of the arrangement of class-room, living quarters, playgrounds and gardens in a typical one-teacher rural school in Denmark is shown on page 8.

In Switzerland, every large schoolhouse includes a residence for the janitor, and the country schoolhouses are also homes for the teachers. On this subject, the United States Bureau of Education, Bulletin 1913, No. 56, "Some Suggestive Features of the Swiss School System," says:

> "In external architecture there is usually a successful effort to make the building harmonize with its surroundings. Especially in the country there is a refreshing simplicity and dignity about the schoolhouse. Since the janitor or the teacher lives at the schoolhouse, it is never characterized by the neglect evident in so many American country schoolhouses, which are deserted for several months in the year. The teacher's garden and the pot plants in the windows of his dwelling upstairs give the school a homelike atmosphere, in marked contrast to that which is too common with us. The plans and cuts of schoolhouses which are exhibited herewith are fairly typical of what was found in the Cantons visited."

Illustrations of typical Swiss country school buildings are shown on page 10.

One of the principal points of rural school improvement urged by Dr. P. P. Claxton, United States Commissioner of Education, ever since assuming the office in 1911, has been the "teacherage." In the Report of the Commissioner of Education for 1913, Vol. I, in his introductory chapter, he urges the consolidation of rural schools, and adds:

> "When such a consolidation is made a good schoolhouse should be built, attractive, comfortable, and sanitary, with classrooms, laboratories and library, and an assembly hall large

Schoolhouse at Gimmelwald, Switzerland Opposite the Jungfrau.

Two-Teacher Country School, Sewil, Canton Berne, Switzerland.
Teachers' Home in Second Story.

Typical Country Schools in Switzerland
(Courtesy U. S. Bureau of Education).

> enough, not only to seat comfortably all the pupils of the school, but also to serve as a meeting place for the people of the district. For the principal's home a house should be built on the school grounds. This house should not be expensive, but neat and attractive, a model for the community, such a house as any thrifty farmer with good taste might hope to build or have built for himself. And as a part of the equipment of the school there should be a small farm, from 4 to 5 acres if in a village or densely populated community, and from 25 to 50 acres if in the open country. The principal of the school should be required to live in the principal's home, keep it as a model home for the community and cultivate the farm as a model farm, with garden, orchard, poultry yard, dairy, and whatever else should be found on a well-conducted, well-tilled farm in that community. He should put himself into close contact with the agricultural college and agricultural experiment station of his State, the departments of agriculture of State and Nation, farm demonstration agents, and other similar agencies, and it should be made their duty to help him in every way possible. The use of the house and the products of the farm should be given the principal as a part of his salary in addition to the salary now paid in money. After a satisfactory trial of a year or two, a contract should be made with the principal for life or good behavior, or at least for a long term of years.
>
> In this way it would be possible to get and keep in the schools men of first-class ability, competent to teach children and to become leaders in their communities. The principal of a country school should know country life. A large part of country life has to do with the cultivation and care of the farm. The best test here, as elsewhere, is the ability to do. The principal of a country school in a farming community should be able to cultivate and care for a small farm better, or at least as well, as any other man in the community. It may be true that 'those who can, do; and those who can't, teach,' but it should not be so. It must not be so if the teacher is to do the work and have the influence in the community that he should."

HOW IT SHOULD BE BUILT.

The teacher's cottage will of necessity be within the boundaries of the tract of land assigned for the school house, or on a separate lot near by. The building site should be chosen so as to give the cottage as good a setting and outlook as possible. It should contain an acre or more to furnish room for a garden patch, a chicken house, a cow or horse stable, and perhaps also room for some demonstration work where elementary instruction in agriculture is introduced in the country schools. Such courses will increase in the future, and it will be well to provide for them in selecting the site and determining its size.

The cottage should be of two or more rooms, depending upon the ability of the district to build, or the possibility of combining with another district for a union school with one or more teachers. The cottage should be warmly and substantially built, for in the long run it is cheaper to build snugly than to pay fuel bills, and the same type of building which is warm in winter is cool in summer. Moreover, cheap, flimsy construction will prove most expensive in the long run for the cottage is to be a permanent institution in the community, and should be built to give many years of service.

Special attention should be paid to details of arrangement since the teacher or teacher's wife will often do her own work, and steps should be saved. A good water supply is the first essential. If possible a bathroom should be provided, and most certainly a cheap but effective method of sewerage disposal. These are items of rural sanitation which are sadly neglected. The proper handling of them will be a permanent example to the rest of the community, and a great factor in the improvement of conditions of country living.

The cottage should be built of the materials most available in each locality and best adapted to its needs. These are easily ascertained upon consultation with the nearest lumber dealer or building supply man. The exterior may well consist of drop siding, rustic boarding, or drop shingles, the interior trim of either hard or softwoods, and the floors of hardwood or rift-sawed softwood, which will wear for a long time without splintering. The exterior should always be kept well painted so as to make an attractive appearance, and to preserve the structure. The interior trim should be stained rather than painted in order to bring out the beauty of the wood-work, and harmonious schemes of color and decoration should be worked out to secure an agreeable, home-like atmosphere.

None of these requirements is expensive. They simply take good judgment in the selection of materials, and good taste in their arrangement. Pleasant surroundings and right living conditions are big factors in making good teachers. An attractive teacher's cottage will permit the employment of capable married men for teachers, who become a permanent and valuable part of the community life. Women teachers who have relatives or families depending on them can also take schools with cottages and have much better living conditions than it would be possible for them to secure in the city, and can so well afford to teach in the country for smaller wages than paid in the city schools.

The principles which should guide in the construction of a small cottage for the rural districts are well stated by Dr. F. B. Dresslar in Bulletin, 1914, No. 12, U. S. Bureau of Education:

> "The cottage for the teacher should be as far as possible a model of its kind for the neighborhood. A beautiful, well-planned, and sanitary cottage on the school farm would help in a definite way to stimulate the farmers to build better houses (not more expensive ones) and to reconstruct to a degree those already built.
>
> What sort of cottage should be built? The complete answer to this question must of course be left to the authorities of the district. There are, however, some suggestions applicable:

1. It should be beautiful and as far as possible should harmonize with the general architectural treatment of the school building, if the latter is a modern type. An architect should be employed and the beautification of the useful be insisted on.

2. It should include a living room, a bath room, a kitchen, a dining room, and a sleeping porch. The number of bedrooms will probably not exceed two, and these should connect with the sleeping porch. The plans for the kitchen should receive a great deal of care, especially with reference to modern conveniences.

3. The sleeping porches should be models for the neighborhood. They should be carefully screened against flies and mosquitoes and should open from small dressing rooms, capable of being used as bedrooms when necessary.

As has been said elsewhere, if the country school is to do the work now generally demanded of it, teachers' cottages are necessary in many parts of the country. There is no practicable way of making the district school the real social and educational center of a community without keeping the schoolhouse open and the agricultural operations under supervision during the summer months. This will of course mean a change in the plan of hiring teachers, and, more especially, it will necessitate the employment of a greater number of men for rural school work. There are many difficulties in the way, and some of them may seem almost insuperable, but progress in country life demands these changes and in time they must be made."

PLANS FOR COTTAGES.

The photographs and sketches of floor plans of several cottages reproduced in this volume chiefly represent adaptations of existing structures to new purposes, or simply the cheapest structure it has been possible to build to serve as a living place for the teacher. But few of the cottages so far erected have been the result of careful planning to meet all requirements for a considerable period of time and of a type which can serve as a model for residences of similar size in the community.

The Washington Cottages.

In her excellent bulletin, ''Teachers' Cottages in Washington,'' Mrs. Preston suggests two types of cottages suitable for conditions in that state, which are equally well adapted to many localities elsewhere. They are as follows:

Cottage for Small District.

Figure 1 is the view and Figure 2 the plan of the one-story house. This provides accommodation for two teachers or a teacher and his family. The living room is 13x19 feet, and is sufficiently large for the dining table in one end. This room is made large so it may be used for receptions, meetings of the school classes, mothers' meetings, and all such assemblies in the interest of the domestic, social and educational life of the community. The bedroom is provided with a bed alcove enclosed with folding glass doors. The window at the end is large and is arranged to open the whole size. With this arrangement the alcove may be converted into a fresh air sleeping room by open-

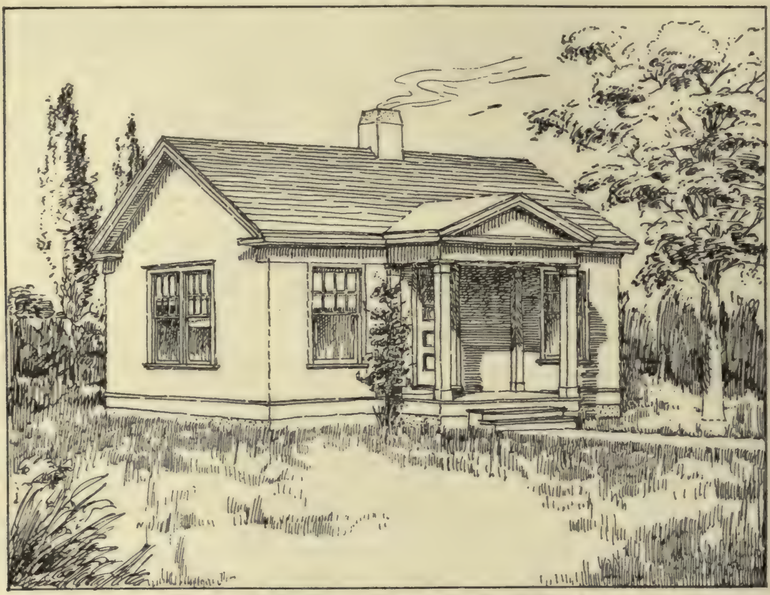


Fig. 1. Model Single Cottage for Small District

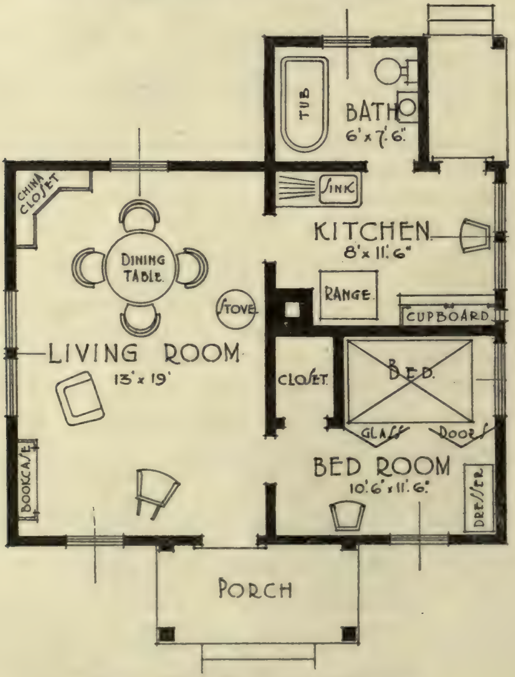


Fig. 2. Floor Plan for Small Cottage

ing the window and closing the folding doors. A large clothes closet is provided.

The kitchen is arranged with a sink, cupboard with shelves, drawers and a cool closet division. A bathroom is shown in connection, which may be omitted if desired. The hot water tank for the bath and sink will be placed in the bathroom. A small cellar is also provided, which may be omitted. Both the front and rear entrances have porches.

The cost of this home complete, without furniture, will be about $900. If the bathroom and plumbing fixtures, except sink are omitted, deduct $250. If the cellar is omitted deduct an additional amount of $50.

The Double Cottage.

Figure 3 is the view and Figures 4 and 5 the plans of the double two-story home. The object of building these double homes is to provide larger accommodation for community social work by using the two living rooms together by opening the double folding doors. This opening has two sets of double doors, and when closed and a quilt or blanket hung between them, no noise can pass from either room to disturb the occupants of the adjoining room. Cellars are provided with stairways from the kitchens. Both the front and rear entrances have porches, and are separated so as to give as much privacy as possible. Two bedrooms are provided on the second floor for each house. The bathrooms are directly over the kitchen and the hot water tank is placed there.

The double home will cost about $2,300. If the plumbing is omitted deduct $200. If the cellars are omitted deduct $100.

While these homes are designed to be substantially and well built, they are constructed of simple stock material, and there are no special detail refinements. Shades and screens should be furnished with the building.

What the District Should Furnish.

It is recommended that the school district provide the following furniture:

1 kitchen queen
1 dining table
1 sideboard
1 small table
1 rocking chair
1 dresser
1 range
6 dining chairs
1 book case
1 easy chair
1 bedstead and spring

The teacher will furnish rugs, carpets, draperies, bedding, table linen and dishes.

We would suggest that the school district charge about one dollar a month for the use of the furniture. The furniture will cost about $125.

For the double house there will be two additional chairs, and one bed and spring. This will cost about $40 additional. In planning the houses for teachers the needs of the teacher and the requirements of community life of the school district have been carefully considered. Cost and simplicity of construction have also been given considerable attention.

Cost and Price of Plans.

The cost given for the homes is the average cost condition in the Puget Sound district. In outlying districts and in Eastern Washington these prices may be 10 to 20 per cent. higher.

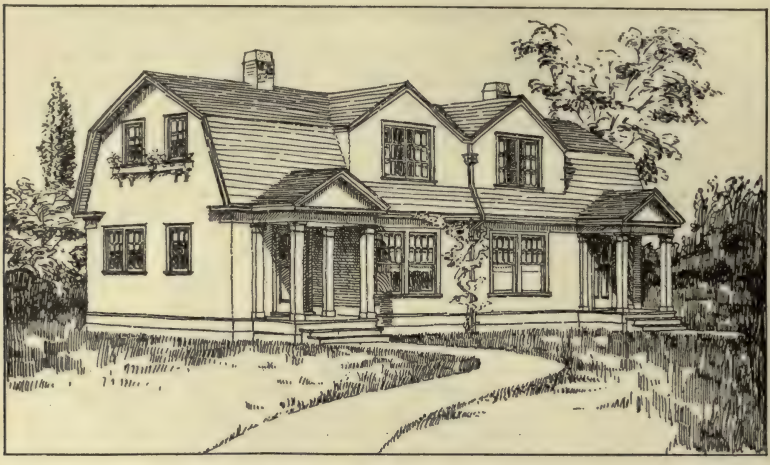


Fig. 3. Model Double Cottage

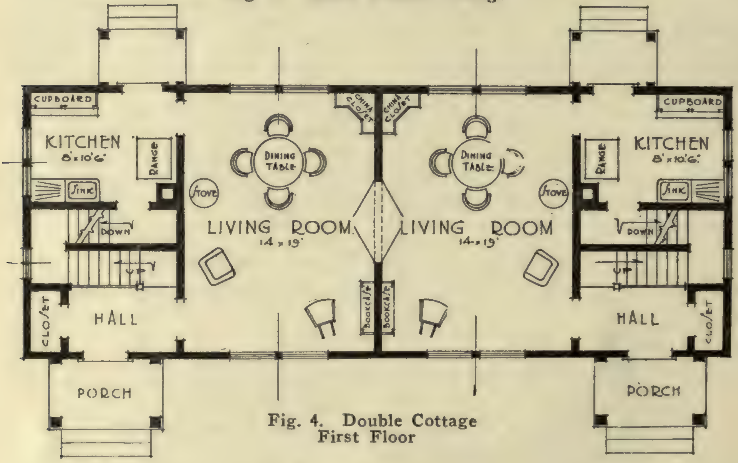


Fig. 4. Double Cottage
First Floor

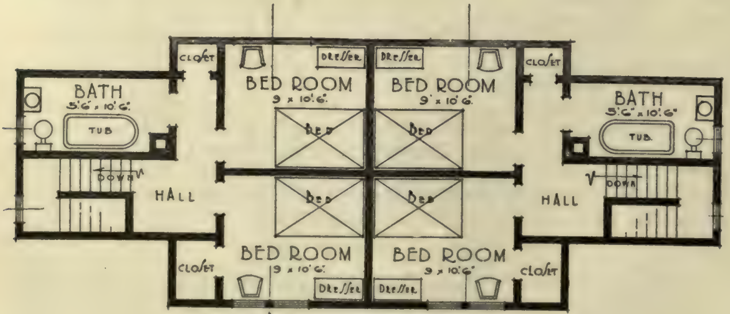


Fig. 5. Double Cottage
Second Floor

Arrangements have been made with the architects of these homes, to provide complete working drawings, specifications, forms for building agreement and bond, for $5 for one set of complete blueprints for the one-story home, and $10 for the double two-story home. School districts desiring them may write to the State Department of Education at Olympia, Washington.

The Radford Cottages.

The plans of a number of teachers' cottages in various parts of the country reproduced in this bulletin, together with the model cottages recommended by Mrs. Preston, show many interesting features of construction. In order to afford school authorities a still greater range of choice, the Radford Architectural Company of Chicago, has, upon request, specially designed the three cottages described and illustrated herewith. They involve no expensive features of construction, can easily be built of the most available materials in each locality, and will present a comfortable, "homey" appearance. Furnace heat is always desirable, but these cottages may be adequately heated by stoves if there is need to save on costs. A good water supply system should be provided by a force pump with a storage tank in the attic, or a pressure tank in the basement, and—still more important—a sanitary method of sewage disposal should always be arranged for. The cost of a septic tank is not great, but the lack of one may bring disaster.

Whatever type of cottage may be decided upon for any particular locality, the effort should always be to make it attractive and easy to do housework in. These are big factors in any residence, and especially important here since the teachers' cottage will naturally be looked upon as an expression of the community idea of home building.

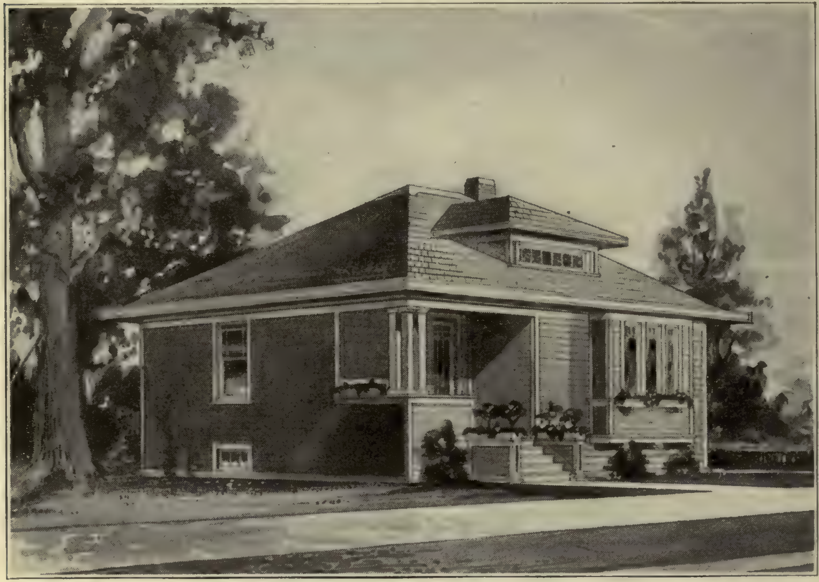
Design No. 1:

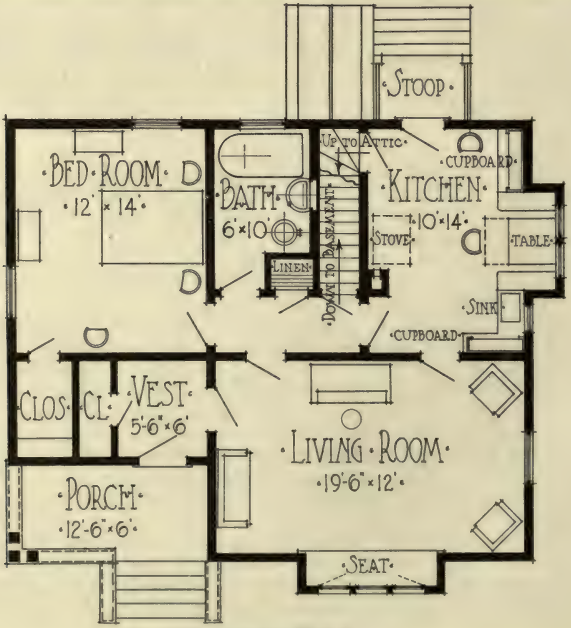
This is a three-room one-story bungalow, with total dimensions of 33'x27½', exclusive of porches and bay projections. The entire basement is excavated and finished with a cement floor throughout, subdivided into proper spaces for furnace room, laundry room, coal bins and fruit and vegetable room. The foundation walls are of concrete to grade level, and from there up, of typical 2x4 frame construction. The exterior is finished with bevel siding, and shingle roof.

The interior contains a combination kitchen and dining-room, with a 3'x3' table, built into the bay projection with benches on each side, which are hinged, and can be let down out of the way when not in use. The end of the table has an 18" hinged leaf, which can be let down when not needed. This makes the table 4½' long, and capable of easily seating five persons when necessary. The cupboard adjacent to the sink contains shelves for dishes and drawers underneath for pots, pans, etc. The cupboard on the other side of the table is of similar type, with a dresser compartment for table cloths, napkins, etc. A metal hood is placed over the stove to remove foul air and gases.

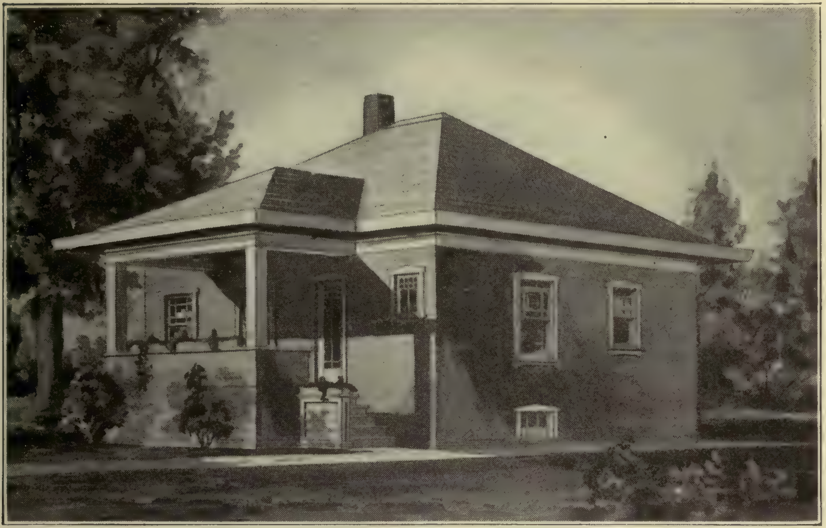
The living-room is of sufficient size to entertain a neighborhood gathering, or in case it is desired to have a dinner party, a dining-room table can be placed in one end of it very convenient to the kitchen. The seat in the bay window has a hinged top, so as to be used for a handy place to store away various articles.

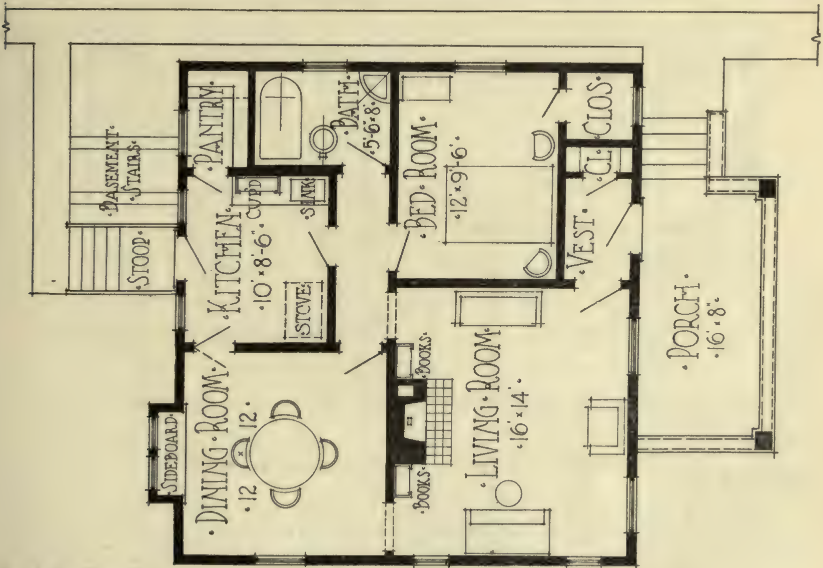
This cottage will very nicely accommodate a teacher and his wife, or two lady teachers, who wish to live together. It is neat and attractive in appearance, and very easy to do house work in.





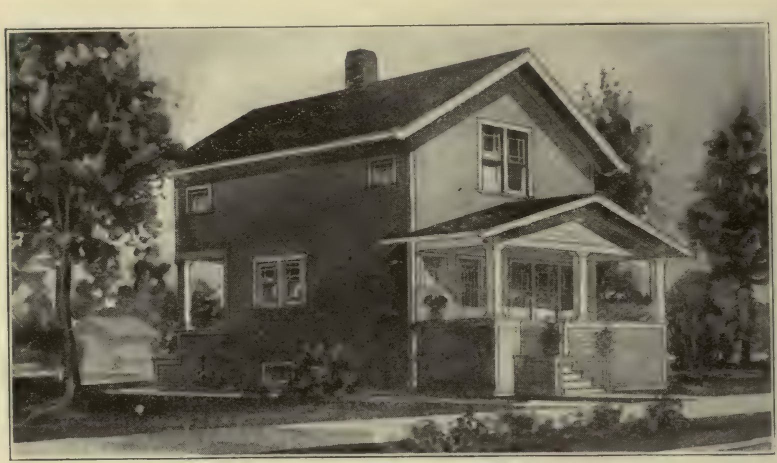
Design No. 1

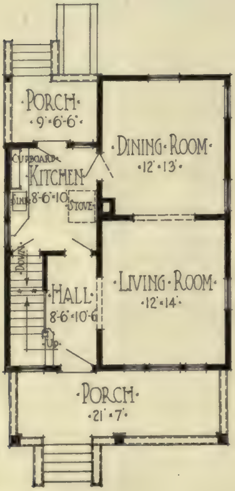


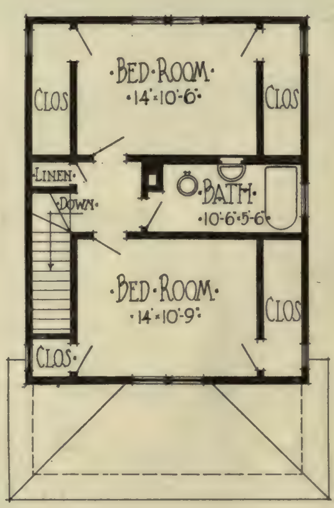


Design No. 2:

This is a four-room bungalow to accommodate the same number of persons as Design No. 1, but has a separate dining-room. The total dimensions are 29½'x27½', exclusive of porches. The exterior is covered with 8" rough bungalow siding, and a shingle roof. The basement arrangement is similar to that of Design No. 1. The kitchen stove is connected to the chimney over the fire-place in the attic. The built-in dining-room sideboard contains drawers and china cases with casement windows above. The living room has a big fire-place and hearth with bookcases on each side.







Design No. 3:

This is a story and a half residence for a teacher and his family, or as many as four lady teachers, if they wish to keep house together. The exterior dimensions are 22'x28½', exclusive of porches. The outside is covered with bevel siding and shingle roof.

The basement is arranged in similar fashion to Designs No. 1 and 2. The kitchen sink has a cupboard directly over it, with shelves for dishes and drawers and also shelves underneath for pots and pans. The living-room and dining-room can be thrown together to make one large room 12'x27' for the accommodation of neighborhood gatherings. A particularly good feature about this design is the two closets in each bed-room with ventilating windows.

AS A SOCIAL CENTER.

The teacher's cottage greatly facilitates the development of ''social centers'' and leads to the use of the school house for many community purposes. The school house thus becomes a continuously operated plant for better citizenship. Upon this point we can do no better than to quote again from Mrs. Preston:

> "The school cottage is being made a social center for the district," is the message that comes from Elmira in our sister state, Idaho. "The parents meet there, and discuss questions that may arise in the school and in their daily work at home, thus enabling the teacher to get in closer touch with them. The children have taken more interest in their school work, on account of the interest of the parents. The same teacher has been employed for two years and will be employed as long as she wishes to teach, neither parents nor teacher having any desire for a change. Before, there was a new teacher every year."
>
> Another social center is reported in a letter from the Snoqualmie principal, Harvey L. Rowley, as his altruistic use of his cottage is a fine example of what many others are doing, and will do in the future.
>
> "As to the use I have made of the school cottage besides that of a home: We have twice entertained the pupils of the high school and the eighth grade including others outside of the school. This we could not have afforded if we were paying a high rent. The pupils have been made to feel that this was their home also, when they have desired a place for their parties. They come to us, and we give them privilege to use the cottage under our direction. They drop in evenings and play on the piano and sing.
>
> "We are trying to make the cottage a social center outside of the school, and the pupils are coming to look at it in that way. We have a well-organized Parent-Teachers' Association, organized this year. The parents are taking a great interest in the work of the school. My work in social center includes the Association just organized, the Farmer's Grange which we are just organizing, an extension course from the University, school athletics, tri-weekly programs at the school and the school hall, and work in agriculture among the farmers."

THE MISSION OF THE COUNTRY SCHOOL TEACHER.

Writing upon this subject in a recent issue of the Countryside Magazine, Addie M. Thayer so well portrays the varied duties and opportunities of the rural teacher that we quote as follows. She tells particularly of Idaho conditions, but what she says applies to a large portion of the country.

> "The country teacher must be resourceful and independent when she is so far from the county-seat. Responsibilities come to her that would never be dreamed of in a more thickly populated country. In the same human spirit in which one little teacher taught fractions, organized a Sunday-School, played tennis with children and parents in the school-yard after Sunday-School, held up the standard of the country dances by her co-operation, took the pupils to a neighbor's barn to judge and

score horses, trained the children in practical manual training by making a walk and gate and whitewashing the fence, and acted as doctor, nurse, and maid when a new little arrival came to a neighbor's home. It was a strange sight for an outsider to see a line of infant's garments strung from school-house to shed. There was no one else to care for the baby, so the teacher took her duty as a matter of course. "If Miss Blank had done nothing else," said one, "She would have been a God-send to us for teaching our children how to play." The first entertainment in that district in years brought out people fifteen miles away. This teacher's vision is broad enough to see beyond the four walls of a schoolroom. She feels that she can best serve the community by teaching those things that parents neglect to do. Unlike the city teacher who has to have faith that in time there will be results, she sees almost immediately a community response.

Does someone who has not the imagination and vision say, "Those things cannot be done unless other school work is neglected"? It is true; much is omitted which educational "standpatters" would still consider essentials. They are neglecting cube root, the names of the mountain ranges of China, the diagramming of sentences, and the details of all the wars large and small; but they are learning more about farm accounts, the geography of their own region, how to write a good letter, and local history.

One young man teacher had the good sense to neglect the formal part of the eighth-grade subjects, even though he might be judged a failure by someone higher up, when his students came to take the eighth-grade examination; but he had brought into his little rural school two red-shirted "lumberjacks" who had left school a year or two before because of discouragement or lack of interest. The athletics, practical arithmetic, and, best of all, the manly young teacher, appealed to the boys, so they were easily persuaded to come back.

Probably the young woman who had her pupils make bird-houses brought more culture into her district than any formal book study could, for the whole community was benefited by it. The same teacher, through her practical agriculture, saved the orchards of the patrons, men who had little knowledge of fruit-growing and who were depending on the future bearing of their fruit trees for their livelihood. When the teacher and her pupils were pruning a neighbor's orchard they found many trees whose roots were eaten by gophers. After further investigation, three hundred gopher-traps were ordered. While waiting for their orchards to mature, the farmers tried to raise other crops, but without much success because of poor soil. Again the young teacher saved the day by testing the soil for acidity and getting a neighbor to experiment by liming his soil.

A new generation of teachers like these will educate future citizens to be more in sympathy with their environment. Then country life will be satisfying. When teachers are thoroughly imbued with the idea of re-directing the rural community, through the school, along more practical, social and recreational lines, they will do more for the "country-life movement" than any other force."

WHAT HAS BEEN DONE.

Although in only a few states have many teachers' cottages been erected, there are one or more in almost every state, and a rapidly growing sentiment that the consolidation of rural schools and the building of homes for the teachers is the next big educational development in the United States. A brief resume of progress follows. Much of this information is taken from an unprinted report of the United States Bureau of Education, prepared from data collected from county superintendents and other rural superintendents. Where abstracts are given from the Bureau report, the quotations are from the reports of the county superintendents to the Federal Office.

Alabama.

The recent law increasing State aid for the erection, repair and equipment of rural school-houses does not make provision for teachers' cottages. However, we are alive to any openings in the state where such buildings may possibly be erected. The Department realizes the value of teacherages, and hopes that with the erection of consolidated schools, this type of building may go hand in hand. (Wm. F. Feagin, State Superintendent, Montgomery, Ala.)

* * * *

Four county superintendents express a desire to have them. Marshall County is now building six houses for teachers. Enterprise, Coffee County, bought a cottage for the teacher and paid for it by popular subscription. Covington County has one rural school with teacher's cottage and six acres of land; charges small rent. Monroe County has one cottage they rent to the teacher. Moran County has two for negro children. Cullman County reports that because they have no cottages many of the married male teachers are forced to give up the teaching profession because in many localities there are no other houses for the teachers to live in. Talladega County reports that their teachers have a good deal of trouble securing suitable boarding places, which is a handicap to the progress of the school. County superintendents advise trustees to secure best boarding place possible for their teachers. Jackson County has one cottage owned by district, furnished free to teachers, a handsome two-story, eight-room building, kept in good repair. By reason of this teachers' cottage this school has been able to engage and hold the very best teaching talent in the county. (U. S. Bureau of Education.)

Arizona.

No teachers' cottages reported.

Arkansas.

School districts are permitted to build such cottages whenever they can and desire to do so. A number of such cottages have been erected in the State in the last three or four years. (J. L. Bond, Supervisor Rural Schools, Little Rock, Ark.)

* * * *

The movement for building teachers' cottages in this county is yet in its infancy, and there is only one in the county. That is a very neat, four-room cottage, built on the corner of the school ground, and is used for a home for the teacher and his family.

In a short time there will be a general move on the part of the rural districts to build homes for their teachers. (J. D. Swift, County Superintendent, Blytheville, Ark.)

Arkansas.

We have one teacherage in this county erected the past summer. It is about four and one-half miles southwest of Bentonville. It is a five-room cottage, well finished, conveniently arranged, at a cost of about $500. This cottage accommodates only two teachers at present, but I think the school will add another teacher next term.

Great interest is being taken in cottages for teachers in this county, and I think others will be built. (W. R. Edwards, County Superintendent, Bentonville, Ark.)

* * * *

We have at present two nice cottages. One three rooms, the other four rooms. They are ceiled, and painted inside. They are intended to accommodate the principal and his wife, who are expected to supervise the house and grounds at all times.

The three-room cottage is in Ada district in the northern part of Crawford County. The four-room cottage is in Mountainburg, also in northern part of county.

We have two large districts just made this year. The school buildings are just complete. Nice cottages will be built in both these districts this year. This will make us four "teacherages" in Crawford County. We are interested in building such schools, and think that this will be the plan of the future school. (Henry W. Shaffer, County Superintendent, Van Buren, Ark.)

* * * *

We have at Scott's Station in this county, a consolidated school, with three teachers, a teacherage, or living cottage for the home of the three teachers. This community is almost an ideal one—a good school-house, with three rooms to accommodate three schools, a community house, where all the public business is transacted, and where they get all their amusements, such as gymnasium, music, etc., and a teacherage, where the three teachers live, hire their cook and housekeeper, and enjoy a delightful home, amid absolutely ideal surroundings, quiet, books, comfortable surroundings altogether.

There is now another movement in the north part of the county, in a rural district like Scott's, at a place called Redoak, where I taught my first school, some twenty-five years ago, a movement to build a teachers' cottage on the beautiful school grounds, and they have recently built a three-room school building, on a plot of five acres, and there is room for this cottage. I had a long talk with one of the directors yesterday about this matter, and I am sure that in the near future, they will provide a nice home for the teachers there. Let us hope that many others will follow their example, and that after awhile (pray that it will be only a little while) every school in the United States will have a home for the teachers on the grounds, supplied with a horse and buggy, or better still a car, a garden and everything that will make the teacher become a permanent profession. (E. R. Robinson, County Superintendent, Lonoke, Ark.)

* * * *

A lumber company at Millville is constructing a building for the teachers. Greenwood, Sebastian County, has two for the elementary schools and reports they have better teachers and better schools than any others of the same class. County superintendent urges boards to build more buildings.

Wynne, Ark., reports that in a rural district ten miles from a railroad in Cross County a beautiful cottage on the campus, is owned by the district and furnished free to the principal and his family. This is the best rural school in the county and perhaps the best in Arkansas. They have had the same principal for six years, and the free cottage does much in helping to hold this valuable man.

Mississippi County has one in a rural community and another in a town of about 1,000 population. Both have proved a decided success. One is a five-room cottage, and if they are not occupied they are easily rented and the rent money goes to the support of the schools. Plan is so satisfactory that other communities are discussing it with intention of building. (U. S. Bureau of Education.)

California.

"Believe plan a good one." Teacher of agriculture in San Jose High School is furnished a cottage free. "Excellent plan." Tamalpais Union High School will build a cottage for the janitor. San Mateo County has a small two-room cottage in the Tunis district built on the school lot because they could find no boarding place for their teacher. They employ a widow with four children. In Los Angeles County there are three cottages rented by the teachers and owned by the county, and five cottages rented by the janitors. San Diego County states that one of their greatest problems is the problem of board and lodging. Kern County reports four cottages and that the experiment is successful because conditions make it necessary. (U. S. Bureau of Education.)

Colorado.

Under the powers given to school boards in this State, it is possible for school districts to erect or purchase homes for the use of the teacher or teachers. Such buildings are usually designated as "teacherages." There are five such teacherages in Colorado at the present time, and I am very earnestly hoping that the number may be materially increased during the next year. (Mary C. C. Bradford, Superintendent of Public Instruction, Denver, Colo.)

* * * *

There is one teacher's cottage in our county. It is a schoolhouse which became too small for the needs of the district, and when they built the new schoolhouse, the old one was remodeled for a "teacherage." It has four rooms and is partly furnished. One teacher lived in it four years. It stands beside the schoolhouse. There are two teachers in the school, both ladies, and are living in the cottage. The District is No. 11 of Mesa County, known locally as the "Pride" School. It is a rich district and employs three other teachers in remote parts of the district. (Mrs. Elizabeth Hinton, County Superintendent, Grand Junction, Colo.)

* * * *

There is a teacher's cottage at Pinon, Colo., seven rooms. Two teachers—family of the principal. Others may be built the coming year. (Lillie O. Baker, County Superintendent, Pueblo, Colo.)

* * * *

We have in Otero County only one home for the teacher, provided by the school district. This building consists of one room 14 ft. x 18, and of a kitchen 14 x 14, which is provided with a sink, and is connected with a cistern in such manner that the water may be pumped from the cistern inside of the kitchen. Underneath the kitchen is a cellar 8 ft. square. The building also is provided with a porch which is 11 ft. x 14, and is planned to be used as a sleeping room, if desired by the teacher. The Board of Education is planning to plant trees in the yard next spring, so that teachers and pupils will be provided with shade. This home is located in a semi-dryland region. The District is No. 1, and the postoffice address is Timpas.

At Weitzer, District No. 18, of this county, an attempt was made two years ago to vote money to build a teacher's home at the expense of the district. For some reason the movement was defeated, and the secretary, who owns a store close by the schoolhouse, leased an acre of ground for an indefinite period from a land owner owning land contiguous to the school grounds, and placed on this leased portion a 4-room building. The

Colorado.

building is in the form of a square, about 26 x 26. It is a very comfortable building for a small family. Their idea is to keep the teacher in the community, and let him be, therefore, a part of the community life. Their school is a 2-room building, and their policy is to keep a male principal. (S. S. Phillips, County Superintendent, La Junta, Colo.)

* * * *

I am sorry to say there are no teachers' cottages in Jefferson County. The nearest approach to one is in one of the mountain districts where one of the patrons built a house for the teacher since it was imperative that the teacher have a boarding place and there was no place in the district where she could go. (Berness Bunger, County Superintendent, Golden, Colo.)

* * * *

There are no teachers' cottages in this county, but some are certainly badly needed, for only this morning a teacher came to me and said she didn't know where she could get a place to stay, no one wanted to keep her; the only American family that had been in the district have moved away, leaving only Mexicans in the district. (S. J. Capps, County Superintendent, La Veta, Colo.)

* * * *

We have one teacher's cottage in this county. This cottage is situated in District No. 5, which is in the north central part of the county, in an agricultural district. It is 24'x24', cost about $700, and has four rooms. It accommodates the two teachers who have charge of the school in this district. (Emma Full, County Superintendent, Montrose, Colo.)

* * * *

In two isolated communities are little two-roomed cottages provided for the teachers. In one case the house is well furnished and cozy, costing $300, perhaps. The other is only a temporary house, costing perhaps $100. (Florence Salabar, County Superintendent, Durango, Colo.)

* * * *

We have no regular teachers' cottages in this county, but there are five districts in which teachers are keeping house, near the schoolhouse. (Allie V. Richmond, County Superintendent, Las Animas, Colo.)

* * * *

We have no cottages for teachers' residences in Logan County, but at Crook and in School district Number 25, rooms have been arranged in which the teachers reside. We are to have a new consolidated school at Dailey, and I hope that a teacherage will be provided there. (Flora A. Allison, County Superintendent, Sterling, Colo.)

* * * *

One district had to build a room for two teachers. A log, two-room schoolhouse is used for the teachers' cottage in one of the rural districts. "We surely need it, hasten the day." "We have one cottage that is a complete success and hope to have more." Three rural districts are now using old schoolhouses partly furnished for the teachers. "Hope to have two at the end of the year." "I wish there were some in my county." In Huerfano County they have adopted the plan of building one or two rooms onto the schoolhouse, in which the teacher may live. These are owned by the district and no charge is made. By having these rooms they are able to employ a better class of teachers and it is more agreeable to the teachers and the expense to the district is small. (U. S. Bureau of Education.)

Connecticut.

In one place the plan has been considered, in another place six teachers rent a house and run their own "mess." (U. S. Bureau of Education.)

Delaware.

In this State there is no movement at all which corresponds with the movement in the State of Washington for the erection of teachers' cottages. I wish we had such a movement and regret to say that we have nothing of the kind. (Charles A. Wagner, Commissioner of Education, Dover, Del.)

Florida.

"I favor the plan, think it a good idea." "A growing demand will bring them in a few years; we need them now." (U. S. Bureau of Education.)

Georgia.

"Planning for some in Hazelhurst." "It will solve some of our school problems."—(Monticello.) "It is the work we need."—(Miller.) One rented in Hoke County. "Would be glad to have them." (Randolph County.) "We are pushing the matter." (Reedville.)

One for colored school in Newton County. Screvin County reports one furnished rent free to teacher. They have an excellent teacher whose good influence is felt in the community during the greater part of the year and whose job is permanent. Fulton County reports four principals who rent farms and live the year around near their schools, farming five months and teaching seven. Montgomery County reports a modern four-room cottage for teachers in a rural section of the country. At Bethsaida and Orianna homes are furnished to teachers rent free. County superintendent remarks, "I had hoped to see many more during next two years, but alas, the war and cotton." (County superintendent of Laurens County.)

Ben Hill County reports two teachers' cottages and finds them remarkably advantageous to the school, and hopes to build as soon as possible a dwelling for the teachers in each school in the county, as they find it almost impossible to get boarding places for the teachers. Clinch County reports the pay of teachers so meager that nearly all teachers are single men or women and consequently there is no need for a home, just a boarding place. In Calhoun County two schools have cottages, one serves as a dormitory for some of the pupils, the other is a very comfortable cottage and serves for the teacher only. Plan is reported successful and the county superintendent will be glad to have one for every school. Spalding County reports that this question is one of the most important to their schools. In some instances they have failed to secure teachers that they wanted because of the difficulty of finding a boarding place. They have one cottage owned by the school authorities, but control four other residences for the use of their teachers. They are striving to provide a cottage for each regular school of the county. Jefferson County reports that it is becoming more difficult for teachers to find suitable boarding places, and the solution of this problem would be held as an important step. Cobb County reports that it is becoming a serious problem to secure boarding houses for teachers. With meager salaries teachers are not able to pay the price of board, caused by high prices and the great disposition to charge them extravagantly for board. (U. S. Bureau of Education.)

Idaho.

In Bonner County at the present time there have been built four cottages by the school districts for the use of the teachers. The first one was built at Elmira, Idaho, three years ago at a cost of about $1,200. It is a concrete building, having three rooms with a good basement beneath. The school building and cottage is in a natural grove of pine and fir trees which has been sowed so that now they have a nice park of blue grass and white clover. The teacher and her sister have occupied the cottage for the last three terms, or ever since it was built. The teacher does the regular school work and the sister gives music lessons

Idaho.

on the piano to the school children, and takes care of the school lunches which are served every noon free by the district to the children. Before the cottage was built the district had never employed the same teacher for two consecutive years. The present teacher will be there as long as she stays in the school work.

The second building was built two years ago and is a frame building. It cost $1,200, and has five rooms with closets and bathroom. The ground belonging to the district is a 10-acre lot which is used as an experiment station for the school. Two acres of the ground has been parked and seeded down with blue grass and white clover. The people of the district take great pride in the cottage and grounds, and in this district, as well as the first one mentioned, from the pride that has been taken in the school grounds the patrons have been led to take better care of the houses and yards at their homes.

The third cottage was built in an Italian settlement, and consists of three rooms. It cost not to exceed $400. This building was built so that the teachers who could not find a good place to board could have a place to live. At this school there are now three young ladies teaching, and they occupy the cottage. It was built two years ago, and since then the same teachers have taught the school. Before that time it was almost impossible to get teachers, and we could never get a teacher to go back the second year. Everything now is kept much neater about the school yards, and the children seem to take more pride in keeping their clothes and bodies clean. This is an improvement that was needed very badly.

The fourth cottage has been occupied by a family of the district that were too far from school to attend. This family moves into the cottage at the beginning of each school season.

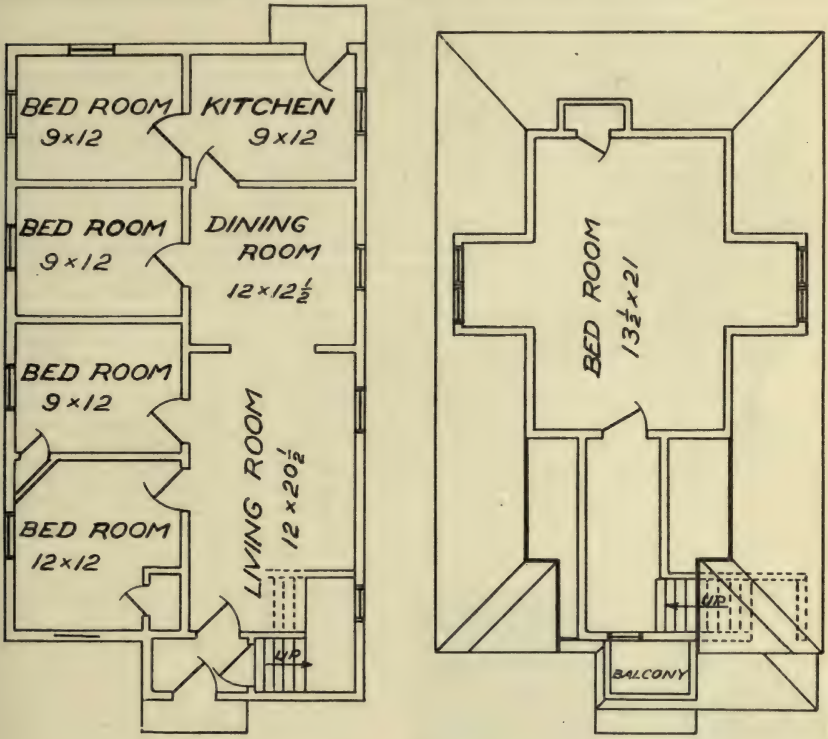
Since these cottages have been built a number of the other districts have taken up the plan, and will build as soon as times get better. The cottage in this county has come to stay, and I hope in the future to see one in almost every district in the county. (J. W. Ramsey, County Superintendent, Sandpoint, Ida.)

* * * *

"Something must be done soon as the boarding place for the rural teacher is an unsolved problem." State superintendent reports that some districts have been able to make patrons open their homes by threatening to build cottages. One community building near Coldwell has not proven a success on account of the difficulty of getting a good principal. In Shoshone County the trustees permit the teachers, a man and wife, to live in the basement of the school building because all the ranch houses are small and there is no other place for the teacher to secure accommodations. Freemont County reports two cottages for the teachers and another in progress of construction. These are two-room cottages and have proven quite successful for the weather is very severe in winter and the snow deep. It gives the teacher much more time for her work and solves the boarding problem. These districts, having a great mileage of railroad, are in good financial condition and can afford to build these buildings. In district 52 the building is used for domestic science and manual training because the teacher is a home girl living within easy reach of the schoolhouse. All of these cottages are well furnished and well equipped for the teacher, free. (U. S. Bureau of Education.)

Illinois.

The teachers' cottage at the John Swaney Consolidated School was remodeled from the old one-room schoolhouse. The school employs six teachers. The teachers board with the janitor, and his family. The Directors secure the janitor, and make all arrangements for the comforts of the teachers. The teachers pay their board. (See illustrations, pages 29, 30.



First Floor Plan Second Floor Plan

Floor Plans of Teacher's Cottage, Consolidated School, Putnam County, Illinois
Remodeled from Old Schoolhouse

At present the Principal is a married man, and lives in another house, formerly used by the janitor. This year 113 pupils are accommodated; 55 of these are in the High School. (Walter A. Paxson, County Superintendent, Hennepin, Ill.)

* * * *

Our teachers' cottage is a two-story frame building with a finished attic. On the first floor there is a large hall, a parlor, library, dining room and kitchen. On the second floor there are five bed rooms and the bathroom. The attic is well finished, making one large well lighted and well heated room. There is a basement under the whole house. We have all modern conveniences, such as furnace heat, hot and cold water and gas light. The building cost $10,000.

The janitor's wife is the landlady. The janitor, his wife, and their two daughters make the teachers' cottage their home. The janitor pays $25 per month for use of the house and charges the teachers $5 per week for board and room. All of the eight teachers get their meals at the cottage, and all but one room there. An illustration of the cottage is shown on page 30. (Alfred Tate, Principal, Consolidated School, Rollo, Ill.)

Indiana.

Several one-room school buildings have been remodeled into dwellings in which janitors of consolidated schools live and board the teachers. (Chas. A. Greathouse, State Superintendent, Indianapolis.)

Indiana.

The cottage at the Wayne Consolidated School is, at present, occupied by the janitor who boards three of the teachers of the schools. It is the intention next year to employ a married principal who will have charge of this residence. The building is connected with the school building for light and water. It is divided into six rooms and a little reception hall. This is the only teachers' cottage which we have in use at this time, although we have others in preparation. We made the mistake when we began consolidation of removing the old buildings, a thing which should never be done.

We have 96 abandoned school buildings in this County, many of which have been converted into residences. Every consolidated school should have its residence and I am quite sure you are right in stating that "A teacher's cottage is proving to be a step in advance towards school improvement in the country districts." (Lee L. Driver, County Superintendent, Winchester, Ind.)

* * * *

"Needs some in a few places." "Under proper conditions I think it would be advisable." Brookville reports the Catholics furnish sisters cottages in four different places in the county, they teaching in the public schools but in all instances the congregation own the school building as well as the cottage, and the township has nothing to do in the matter except to pay rent for the school building. Kokomo, Ind., has one small cottage for the principal in an elementary school. Reported the plan is a good one. (U. S. Bureau of Education.)

Teacher's Cottage at John Swaney Consolidated School, Remodeled from Old Schoolhouse, Putnam County, Illinois

Teachers' Residence at Consolidated School, Rollo, Illinois. Eight Teachers Board at This House and Seven of Them Room in it

Iowa.

In three new rural consolidated districts they are planning to build cottages for the principals. (Stone Lake.)

In one rural district the patrons oppose the completion of a house for the teacher, partly built. "Board is quite a problem in Scott County." In Clay County two six-room cottages are built for two of the consolidated schools, one at Garfield Center and one at Cornell. They are rented free, the principals are paid $100 per month, the teachers board with the principal. They are very successful. Apponoose County reports they would be fortunate if they did own homes for the teachers for the question of board in the rural districts is a serious problem. They have had a few cases where the teacher could not secure board within the school district and was required to board out of the district. Dooly County reports one public school having a teacher's cottage that has proven very convenient and satisfactory to all concerned. Lyon County reports, "There is no question in my mind that homes furnished to teachers in many of our towns and cities, even if a reasonable rent is charged, would prove of invaluable aid in that it would free from her mind the care of finding suitable and welcome homes in many of our towns and cities."

State Superintendent reports that consolidated districts are giving this matter consideration and expect to have many more of these homes in the near future. (U. S. Bureau of Education.)

Kansas.

There is nothing in the school laws of Kansas that would permit the issuance of bonds for the purpose of buying or building a teachers' cottage. If this could be accomplished by the issuance of warrants or paying out the money on hand, there will probably be no legal objections.

I agree with you that the teachers' cottage is one of the future necessities, if our rural schools are to be continued, and even if they are to be improved on the plans of consolidation, even then the cottage will be a future necessity that more maturity of mind and stability of position be secured. I hope that Kansas will soon follow the splendid example that Washington has set. (W. D. Ross, State Superintendent, Topeka, Kansas.)

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Four county superintendents report great difficulty in securing a boarding place for the teachers and will welcome any plan to solve the problem. One remarks, "At the rate the board is soaring I think it will soon come." Four county superintendents report that they think it an excellent plan and that they need it. One reports the plan not feasible "Because we have generally ladies aged from 18 to 25." Garden City, Kansas, reports that some of their teachers have to pay one-third of their wages each month for board and do not near get what they pay for, and then sometimes have to walk from one to three miles to school. Stafford County reports that two girls taught in adjoining districts, rented a tenant cottage from a farmer, living about midway between the two schoolhouses, and by boarding together they managed to teach in their respective districts. He reports that all the teachers have a great deal of trouble getting places to room and board and when they do find a place to board the price is as high if not higher in the rural districts than in town and the wages are much lower. (U. S. Bureau of Education.)

Kentucky.

"Believe plan an excellent one." "I greatly favor plan." County high school in Breckinridge County has a teachers' cottage. Oldham has one in a rural school. "I hope to see the time come when every school building will be equipped with a teachers' cottage."—(Franklin County.)

Kentucky.

"The problem of a home for the teacher is each year more and more difficult to solve, which is, I think, a strong argument for centralization and consolidation of rural schools."—(Owensboro.) One school in Owen County furnishes a home for the principal and family free. County superintendent thinks this idea needs pushing to the front as it is so difficult for teachers to secure board. Montgomery County reports it is impossible for teachers in some districts to get board, consequently cannot get good teachers to take some of the first-class schools, boarding conditions being so deplorable. County superintendent says, "I said this fall I could see no way out unless we built a school home on schoolground, or rooms over school building, or a cottage. I am one who would be so glad to know what to do in the matter for I am anxious to do the best for our children." Cumberland County reports that in one of the graded schools the building is large enough to have rooms for the principal and family and all of the teachers. (U. S. Bureau of Education.)

Louisiana.

Special departments of domestic science are operated in about two hundred of our public schools. These departments are supported partly by special state aid. A number of domestic science cottages have been built in the various parishes. The parish school boards have ample authority in law to build cottages for the purpose of providing quarters for the domestic science work. (T. H. Harris, State Superintendent, Baton Rouge, La.)

* * * *

"Such a move would be good as the teachers do not stay long enough in a place." "Have been considering the matter." "The city of New Orleans gave recently several thousand acres of swamp land, 1,000 acres of which was to be set off as a home for teachers but nothing has been done toward accepting the gift." "Two rural consolidated schools are now planning to build homes for the principal." (Lafayette Parish.)

"Choudrant has established an agricultural and domestic science high school and in connection with this school purchased and remodeled a six-room cottage; also furnished it completely as a teacher's home." The agricultural teacher is kept the entire year and they have 20 acres on the school farm and campus.

De Soto rents two cottages owned by the school authorities to the principals but it is the intention to give them rent free as soon as the district is out of debt.

Three other parishes are to try teachers' cottages.

Avoyelles Parish reports one cottage and that the experiment has proven very successful.

Lincoln Parish is attempting to have 20 acres for every consolidated school in the parish.

The Olla Agricultural School furnishes a cottage as a home for the principal where the other teachers sometimes board. The school term is nine months and the agriculturist gives his entire time to the work. They report the plan a success and wish for one in each district and parish.

Monroe reports one cottage used by the teacher at Swartz rent free.

The Dodson Agricultural High School owns a home for the principal but rent is paid.

Grant Parish reports one school cottage that they own and let the principal of the school have free of rent and by that means save some funds in his salary that will eventually pay for the cottage. (U S. Bureau of Education.)

Maine.

A home for the residence of the teacher has been, I believe, constructed on one of the islands which is a part of the town of Jonesport or

Jonesboro. There has been some agitation in some of the other towns for teachers' cottages or for housekeeping rooms connected with school buildings, but inquiry has failed to bring out definite information as to these. (Payson Smith, State Superintendent, Augusta, Me.)

Maryland.

"Nothing has been done in Maryland along the line referred to in the bulletin of the State Department of Education of Washington. (B. K. Purdum, Assistant State Superintendent, Annapolis, Md.)

Massachusetts.

Three years ago a house was built for the principal of the high school at Hadley from funds belonging to the school by private bequest. It is an eight-room house, costing about $5,000. It was planned by a former principal, Mr. J. E. Heald, now of the Bureau of Agricultural Education, Department of Agriculture, Washington. It is very attractive and convenient.

Last year a small cottage on the high school grounds was fitted up for teaching household arts. In the upper story two rooms were fitted up for teachers' use. The Domestic Science teacher and two other teachers room there. The pupils in the school do practically all the housekeeping. (Clinton J. Richards, Superintendent, Hatfield, Mass.)

Michigan.

"Would like to have the plan tested." (Traverse City, Mich.)

Alger County reports that at Limestone a house is furnished rent free to the teacher and that this house is owned by the township school board.

Also at Chatham a house owned by the township is furnished rent free to the township superintendent.

Menominee built a bungalow for the county agricultural school which is now used by the superintendent. The cost of this house was $3,000. They also built a house for the janitor at a cost of $1,800. These houses were built because it is necessary to keep these men on the premises during the entire year. (U. S. Bureau of Education.)

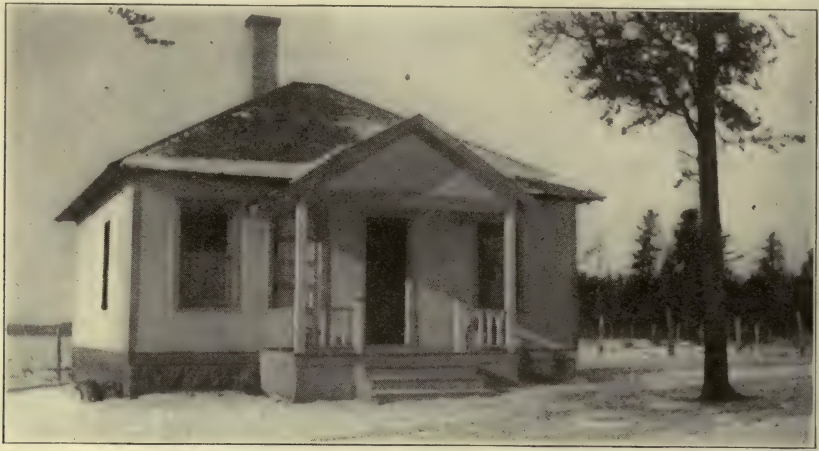
Minnesota.

The sections of the Minnesota school laws which bear particularly on this question are quoted as follows by C. C. Swain, Rural School Commissioner, St. Paul, Minn.:

"Section 1. Two or more school districts of any kind may consolidate either by the formation of a new district or by the annexation of one or more districts of unorganized territory to an existing district in which is maintained a state graded, semi-graded, or high school as hereinafter provided."

"Section 8. For the purpose of promoting a better condition in rural schools, and to encourage industrial training, including the elements of agriculture, manual training and home economics, the board in a consolidated school district is authorized to establish schools of two or more departments, provide for the transportation of pupils, or expend a reasonable amount for room and board of pupils whose attendance at school can more economically and conveniently be provided for by such means; locate and acquire sites of not less than two acres, and erect necessary and suitable buildings thereon, **including a suitable dwelling for teachers,** when money therefor has been voted by the district. They shall submit to the superintendent of education a plat of the school grounds, indicating the site of the proposed buildings, plans and specifications for the school building and its equipment and the equipment of the premises."

Minnesota.



Teacher's Cottage in St. Louis County, Minnesota

"Section 10. The principal of a consolidated school shall be qualified to teach the elements of agriculture, as determined by such tests as are required by the superintendent of education. A school of this class shall have suitable rooms and equipment for industrial and other work, a library, and necessary apparatus and equipment for efficient work, and a course of study embracing such branches as may be prescribed by the superintendent of education."

* * * *

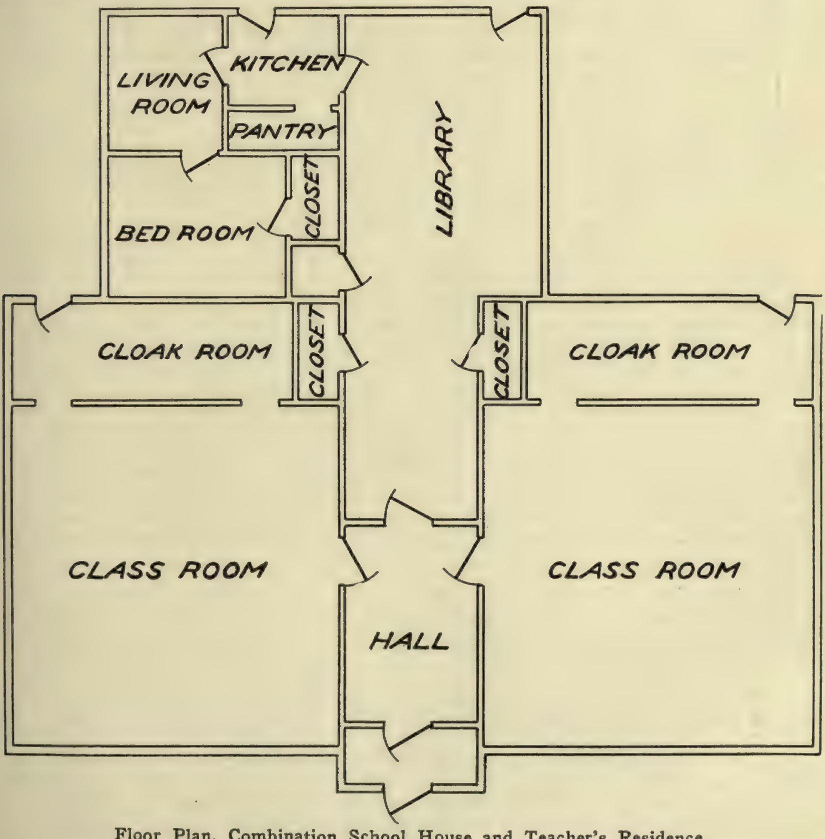
We have teachers' homes at the following schools in what is known as the unorganized district of St. Louis County; No. 14, four teachers; No. 40, two teachers; No. 41, one teacher; No. 45, two teachers; No. 56, two teachers; No. 68, two teachers; No. 71, three teachers; No. 73, one teacher; No. 70, two teachers; No. 83, three teachers; No. 85, three teachers. There are about an equal number of cottages for teachers in the rural schools in other districts of the county. Our plan for these buildings is not uniform, but in all cases except one the cottage is a part of the main building. (See illustrations, pages 34, 35.) Our object in making the cottage a part of the main building is to economize in the matter of cost of construction and to enable this little household to be used in connection with the instruction of the children in domestic arts. As a general rule the cottage part of the main building costs us about $600, and in addition thereto we are at an outlay of $300 for furniture. The buildings are equipped completely in every way with all the necessary furniture and kitchen ware. This method of taking care of the teachers we are following up, not because it is impossible to secure boarding places in all instances, although that condition of affairs frequently prevails, but rather because it enables us to secure better talent and to retain our teachers for a longer period of time. No rent is charged, and no charge is made for fuel. The teachers live usually at a cost of from $5 to $10 a month each. (N. A. Young, Superintendent of Schools, Duluth, Minn.)

* * * *

When I came here the first of August, 1913, to take charge of this school, there was no house available, and, as you may know, this school is five miles from Barnum and two miles from Nemadji, it was up to some one to provide a house, and as the laws of Minnesota did not permit the district to bond for such purposes, some one else had to come to the rescue, so eight of the patrons signed a joint note for nearly $1,000 and asked me to draft a plan, which they accepted. The house is only partly finished and won't be completed before next summer. I succeeded in getting our Senator to put a bill through permitting the district to bond for such purposes, but they stopped too soon as they did not authorize the State Investment Board to loan state money for that purpose, so we had to levy $1,100 to buy the house as it stands and next year we will levy again the same amount, and then can complete the house without bonding.

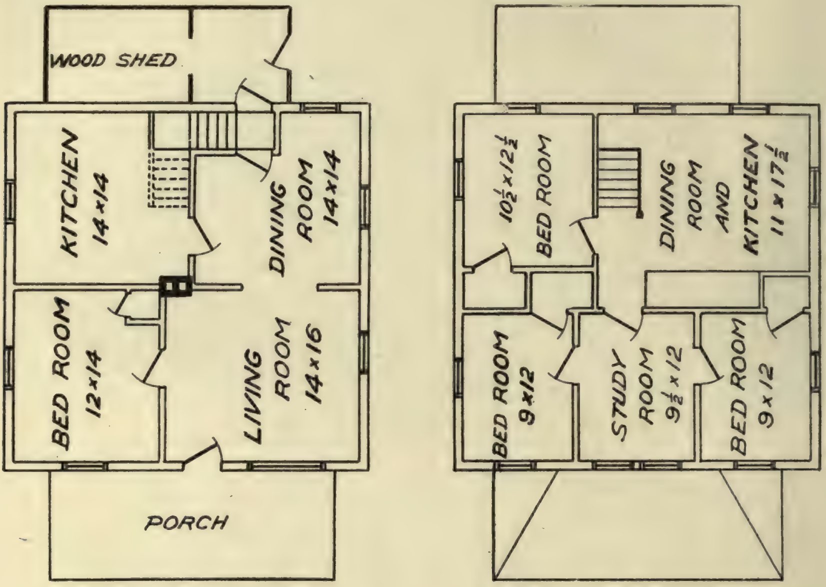
It makes a pretty stiff tax but after two years it will be paid for. It will cost about $2,200 as near as we can tell. It may be a trifle less according to a contractor's estimate on the completion of the house.

The house is 26x30, and will be two stories high, with a plain roof and a deck 8x10. It will have a porch in front 9x22, and a woodshed and enclosed porch in the rear, and the enclosed part of the porch will cover the outside entrance for the teachers to go upstairs, as that will be for them. We have four rooms downstairs with dimensions as follows, as near as I can remember: Front room, 14x16. Dining room, 14x14. Bedroom, 12x14. Kitchen, 14x14, with the exception of cellar way and stairs on part of one side. (See floor plans, page 36.)



Floor Plan, Combination School House and Teacher's Residence, St. Louis County, Minnesota

Minnesota.



First Floor Plan

Second Floor Plan

Floor Plans, Teachers' Cottage, Barnum, Minnesota

The upstairs will have two bedrooms for teachers and a sitting room between, and a dining room and kitchen combined about 16x16, and a bedroom for a girl if they want to hire someone to do the work. Her room is off from the kitchen and is not connected with their apartments. Each bedroom is provided with a good closet. The house will have a hot-air furnace, but no bath or toilet. The cost of the furnace is not included in the $2,200 mentioned before, as I did not want a furnace while I was here, as I know how hard it is to heat a house to suit lady teachers, and as yet I haven't gone into the janitor business and I don't expect to, so there won't be any furnace as long as I stay, but they are building so they can if they wish to later on. I have my reasons for not wanting to be under any obligations whatever to the teachers who are teaching under my supervision, and I feel they are well grounded after my experience here.

I feel that the teachers' home is the only solution of the teacher problem in the small towns and rural communities, but I am convinced there should be no responsibility between superintendent and teachers as to rent, heat, or anything of the kind.

The house will accommodate the superintendent and family and four teachers if they hire their work done, and six if they do not, and I am sure from past experience they will do their own work, as it is much cheaper. We have a good three-year High School, and as soon as our enrollment forces them to build an addition, which they plan to do later, we will put in the full High School course. (E. V. Hemsworth, Superintendent, Consolidated School District No. 8, Barnum, Minn.)

Mahnomen County reports one district furnishing a residence for the teacher and says, "I wish every school in our county could have buildings like this, as the teacher feels as though she really has a home and she is not inconvenienced by long walks through the bad weather and does not have to build fires and wait in a cold room for the room to heat. A place for the teacher to board is one of our greatest problems, and in a home furnished the teacher as above she does not feel like an intruder as she often does when boarding with a private family."

A consolidated district, No. 9, near Morris, furnishes a residence for the principal and two lots of ground. They charge rent sufficient to keep up the property. The plan is satisfactory.

In Red Lake County cottages are very much needed, as in many cases teachers are boarding under very unfavorable conditions, and in some cases the schools were compelled to remain closed. The Saum consolidated school has a building used for such a purpose.

In Carleton County one of the consolidated schools was compelled to build a house, as the principal informed them he would have to resign if no accommodations could be made. The freeholders of the district formed a building association, borrowed money on a joint note and built a building of six rooms. This building was placed on blocks so that it can be moved if necessary, as the state has given no authority to build buildings on school ground. The district rents the house to the principal for $140 a year. The principal rents rooms to teachers, who board at his home. The building association do not expect to make money out of the project nor do they care to lose any. Their intention is to turn it over to the district at cost as soon as the law allows them to do so.

Stearns County has 22 districts that provide teachers' cottages rent free. In all instances these schools are of the one-room rural type and are taught by married men. The salaries, in addition to the use of the cottage, approach about $650 per year. In a number of instances a plot of ground from one to thirteen acres is placed at the disposal of the teacher. Many of these men have been in their respective positions for a number of years and are giving good satisfaction. (U. S. Bureau of Education.)

Mississippi.

George County. In a consolidated district the old two-room two-teacher school building was transformed into a home for the principal and they have a splendid man and his wife as head and primary teacher whom they could not have secured without this home. They report that this example of a teacherage is encouraging other school districts to take up the matter and they hope for many more teachers' cottages.

Jackson County at the Daisy-Vestry School, a rural school 30 miles from a railroad, has a cottage called a dormitory across the road from the school. It was built about five years ago by a donation of land, labor and material. Up to that time the teacher had to board about two miles from the schoolhouse as the district is thinly settled and the schoolhouse is located between two settlements. The house is located on 80 acres of land and belongs to the school. (U. S. Bureau of Education.)

Missouri.

An old cottage at Bigelow on grounds recently acquired. Will be remodeled by the School Board. (S. W. Skelton, Bigelow, Mo.)

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"The question of good boarding places is fast becoming a problem. Hard time to get any boarding place." "In my judgment this would be the greatest means toward securing better teachers for longer terms." (Picture of the home of a Franklin County teacher, showing that some teachers live in tents in Missouri, was enclosed.)

"The city of Bloomfield furnishes a cottage for the superintendent." (U. S. Bureau of Education.)

Montana.

We are very glad to have the school districts erect cottages for the use of the teachers where they can do so. There are, however, very few rural districts in the State where such cottages would be specially desirable, that are financially in a position at present to do anything about the matter. (H. A. Davee, Superintendent of Public Instruction, Helena, Mont.)

* * * *

Park County. One rural district built a two-room teacher's cottage near the schoolhouse and connected it by a good walk to the schoolhouse. If the teacher is a young girl and timid about staying alone, one of the big girls who lives quite a distance from the school stays with her. They report it a success.

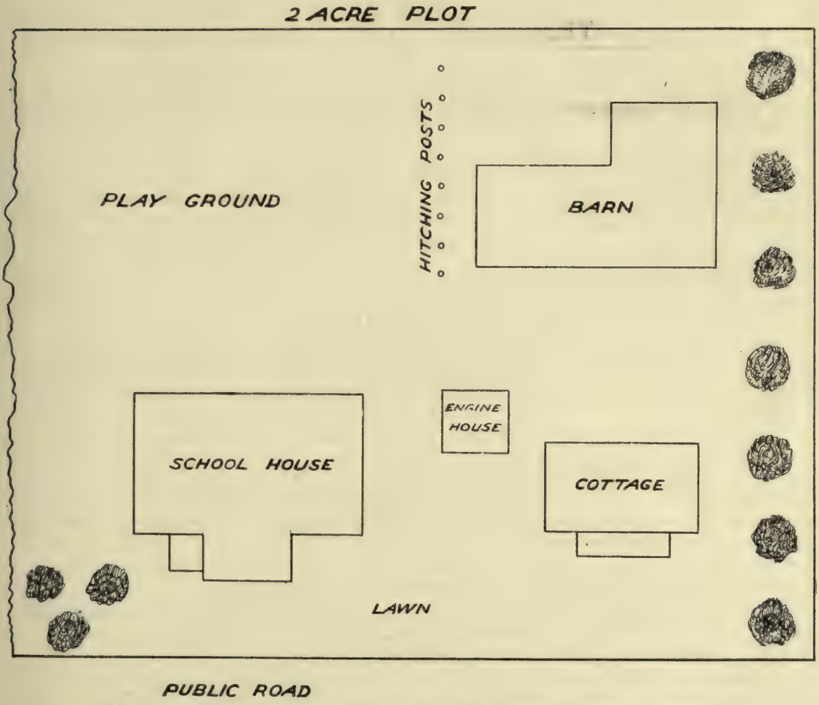
Blaine County reports that a number of teachers live in their own claim shacks and have the pupils come to them and that by this plan the teacher in her own shack is not subjected to the nervous strain and does not hear the gossip of the neighborhood nor worry over the criticisms which are the lot of the teacher boarding with one of the patrons.

Cascade County reports one teacher's cottage which is claimed to be satisfactory. (U. S. Bureau of Education.)

Nebraska.

This is a consolidated school, value $7,500. Was built by bonding district; main building, 54 x 32, with 10 x 20 entrance; library, 10 x 11; porch with hall eight feet across the building. Enter from both north and south side; full basement, 54 x 32; Domestic Science room, 32 x 26;

Schoolhouse, Teacher's Cottage and Barn for Pupils' Horses, Berwyn. Custer County, Nebraska. School Board in Front of Schoolhouse. Teacher Feeding Chickens in Barnyard



Layout of School Grounds, District No. 33, Custer County, Nebraska

girls' toilet to front, 8 x 22; boys' toilet to back, 12 x 22; front room, 12 x 28. Pressure tank; hot and cold water; water furnished by gas engine, pumped direct to pressure tank; a complete generating system. The foundation is of cement and pressed brick; hot air heat; cost of building, equipped, $4,500, exclusive of furniture. Have a high school of first class up to 10th grade. This is our second year in the new school house. We will clean up our indebtedness this year. We pay our principal $85; primary teacher, $55; furnish principal with cottage and room for keeping chickens. Have two acres of ground; six cherry trees, 45 shade trees, small, but this is a fine valley, situated fourteen miles southeast of Baker, on Billings Line B. M. R. Our school house is situated about 300 yards south of R. R. line, five miles west of Ansley. We expect to increase our grades as we need them. I will send you a rough sketch of school grounds and the location of same. (See illustrations, pages 38 and 39.) We have fourteen high school pupils; thirty-eight primary pupils. (J. H. Linder, Director, Dist. 33, Berwyn, Custer Co., Neb.)

evada.

McGill, White Pine County, has a six-room house occupied by six teachers and equipped with all modern conveniences. It was built by the trustees because no suitable boarding places could be obtained and has been most advantageous to the community. (U. S. Bureau of Education.)

ew Hampshire.

No teachers' cottages reported.

New Jersey.

Reports no teachers' cottages. (U. S. Bureau of Education.)

New Mexico.

One place is trying the teacher's cottage plan this year. It is a serious problem in this State in many districts. (U. S. Bureau of Education.)

New York.

Reports one teacher's cottage (Nassau County) valued at $5,000 rented to the principal at a reasonable rent, also one cottage used for janitor.

Another one is not owned by the district but given rent free to the superintendent. One of the buildings is so divided that the teacher lives in one side and the school is held in the other. Two of the district superintendents wished for teachers' cottages near districts and two did not. Another reports that board can always be obtained in good families at reasonable compensations and that the teacher occupies a good place in the social scale and that her company is much sought after in rural homes.

Putnam County reports one cottage which the teacher receives rent free. The cottage is owned, however, by William Church Osborn of Garrison. Mr. Osborn owns and runs a free circulating library of which the principal of the school is the librarian. For this work, Mr. Osborn pays a salary and furnishes him a very fine home. He also receives light and heat free.

Portland County has a teacher's cottage for the union school at Truxton but at present it is occupied by the janitor.

Saratoga County, second district, reports that there are several localities where it is with the utmost difficulty that a teacher can obtain any kind of a suitable board or lodging place and that this is one of the great obstacles in the way of obtaining any kind of proper teaching in the rural districts. The only way that they can obtain teachers is to get a license for someone in the neighborhood who can board at home and this often results in maintaining school to comply with the law but not with any idea of improving the mental condition of the pupils in the school. But he reports that "the people of these communities are apparently satisfied with conditions as they exist but the problems that these conditions present to the superintendent are so many and so varied as to try the ingenuity of the best, it seems to me." (U. S. Bureau of Education.)

North Carolina.

Hoke County reports that all the high schools are well provided with nice homes for the principals located on the ground. In two of the country districts, homes have been built where they attempt to get a man and his wife to come and teach the school. These are all in two-room districts. In this county it is a new feature but they believe it is going to prove very satisfactory. The County Superintendent remarks, "We hope to soon be able to employ the teachers for the whole year and have them do odd jobs in the summer like looking after the library, conducting community meetings, taking the census, looking after the corn clubs and the canning clubs. We hope to use these homes for teaching domestic science on a small scale and serve a hot lunch occasionally to the school. We want to make the teacher a permanent factor in the community all the year round."

Gates County has a dormitory used as a teachers' home for which the teacher pays rent and also for the land attached—about 25 acres. This land, however, is sublet and no demonstration work is done. Union County reports one teacher's home at the high school of Wesley Chapel and the County Superintendent believes that the teachers' cottage adds a great deal to the equipment of schools like Wesley Chapel. Cleveland County reports one teacher's cottage in the Belwood School where the principal lives all the year and manages the school farm of 10 acres. Iredell County has a dormitory in connection with the Farm Life School which is occupied by the teacher of agriculture. Pamlico County is erecting an eight-room home at the expense of the district at Merritt. The County Superintendent says, "We are meeting with many inquiries as to how we raised the money for this work, etc., and in reply to them all will say that the good people went down in their jeans and gave me the money to erect this home with. We are able to get more efficient teachers for the same money and they live happier and better and are giving us better service than they can where they have to adapt themselves to the condition of any family that they live with. This home will be the community center of this place, we are sure, from the way things are developing now."

Wilson County. At the Rock Ridge County high school and at Lucama there are dormitories that the teachers use as a teachers' home. These dormitories are furnished by the school. Two cottages, one at Yadkinville and one at Courtney, are furnished to the teachers but the teachers are required to pay the insurance on the building. (U. S. Bureau of Education.)

North Dakota.

Twenty-two cottages were reported to the State Department last year and they were a success.

Crosby County. The teacher built her own house from money earned by giving a social. In McHenry County, one old school building was fixed over for a teacher's cottage. One county reports a five-room modern house built for one of the two-teacher schools and a two-room house built for a one-teacher school. Buckingworth County reports an old schoolhouse built over for a teacher's cottage. Burleigh County reports one district remodeling the old school building and one preparing plans for a teachers' home in connection with the new schoolhouse. Hettinger County reports several teachers living in the schoolhouse because suitable boarding places could not be secured. This is satisfactory where the teacher can get some girl pupil to stay with her.

In Lamoure County, the consolidated school district of Glenmore rebuilt one of the old schoolhouses and used it for a teacher's cottage, furnishing it rent free. In another district a room was built on to the one-room rural schoolhouse. In this district (Ray) it was practically impossible for the teacher to find a suitable boarding place as the neighborhood was entirely made up of foreigners. This room was equipped with a blue flame stove, cot, etc. The teacher furnished his own bedding.

Bowman County. The Beaver District owns two small houses which are used by the teachers free and the Sunset Butte District owns one similarly used and it will only be a short time before they have two such cottages in their rural districts on account of the difficulty of securing board and boarding places.

Williams County has two districts with teachers' cottages, one a consolidated school district and one a one-room rural school building where the old building was converted into a very comfortable home for the principal's family. All are free and the plan has worked admirably. On stormy days the pupils are taken care of by the teacher until the parents come to take them home. This seems to have worked to the satisfaction of this district.

Walsh County reports that in a consolidation of three one-teacher one-room schools, two of the old school buildings were moved on to the grounds and remodeled into teachers' cottages. This will furnish a home for the principal and two assistant teachers, the use of the cottages being free. Ransom County reports five in the consolidated school districts and also remarks, "I am pleased to say that it is an unqualified success. Stutsmore County reports one teacher's cottage in the school yard which accommodates the principal and his family and two teachers. It is very satisfactory." (U. S. Bureau of Education.)

Ohio.

Knox County has a teacher's home at Mount Vernon which is a comfortable and substantial residence occupied by city superintendent of schools, a fair rental price for which is figured as a part of his salary. Superintendents have occupied this residence for the past 21 years at least.

Union County reports a "domin(ie)age" located at Allen Center on the school grounds—a full-sized house. The principal lives in it with his family and boards the other teachers. The plan is entirely satisfactory so far as the superintendent knows.

The superintendent of Mahoney County remarks that with the advent of centralized schools this is just what Northeastern Ohio needs and that a bill before the legislature a few years ago asking for this very privilege failed.

The superintendent of Jefferson County states that "it is now a problem for us." No place to stay; must get a teacherage in the district, are very common statements. Many teachers travel many miles to and from school—some as a matter of choice, some of necessity. The school loses.

Hocking County reports that it is a serious problem for them to keep the teachers on account of no living place available. Defiance County reports a fine dwelling house in the Bryan village school which is occupied by the head of the school. It has been a great factor in aiding them to get good men for superintendents. (U. S. Bureau of Education.)

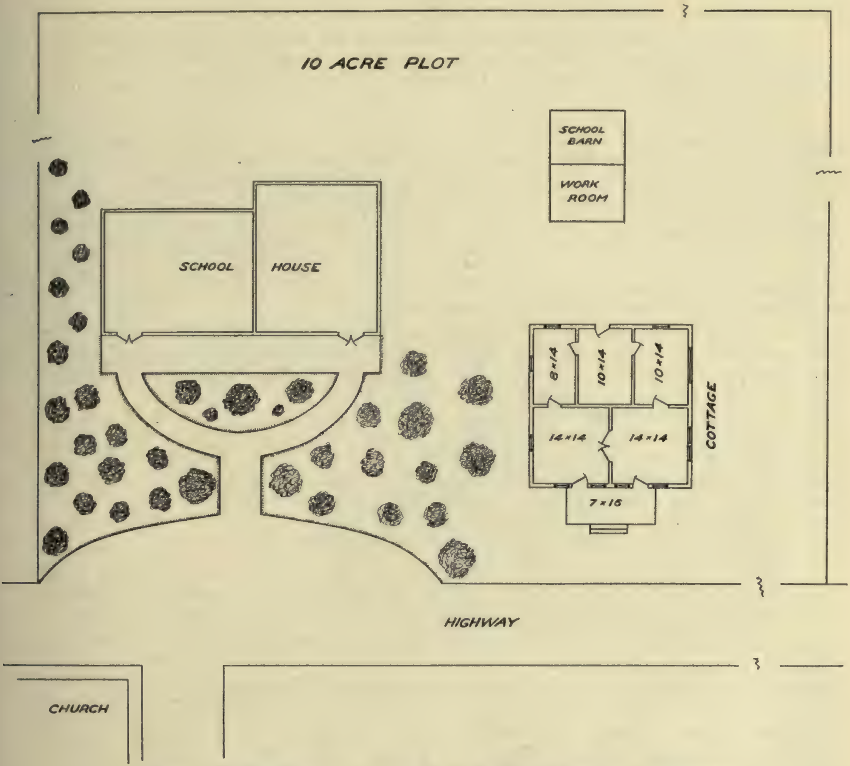
Rural School and Teacher's Cottage, McClain County, Oklahoma

Oklahoma.

In reply to your request for information regarding the establishment of "Teacherages" in McClain County: I am enclosing a picture of one of our rural schools which also shows the cottage. I am also enclosing a rough pencil sketch of the floor plan and the general plat of the school grounds. (See illustrations, pages 42, 43.)

As you will note from the picture the grounds are not yet highly improved as they will be in the future. This you know is a new State, and we cannot do all at once, but there are some great improvements being made.

In my opinion the teachers' cottage comes nearer solving the problem of rural education than any other one idea yet advanced. It would take several pages to discuss the many benefits resulting from it, and



Layout of Rural School Grounds in McClain County, Oklahoma

then it must be seen to be appreciated. Many apparently necessary evils of the rural educational problem find their solution automatically in the establishment of a permanent home for the teachers.

We hope to some day have a teachers' home for every schoolhouse in McClain County. As yet we do not have a great many. They are rapidly attracting the attention of educators and officials everywhere; in fact, the demand for information has been so strong that I shall have to request you to return the enclosed picture as soon as you have made your sketch. (S. M. McCuistion, County Superintendent, Purcell, Okla.)

* * * *

There are two teachers' cottages in the county. (See page 45.) They are not expensive buildings; in fact, they are just box houses. They were put up merely as an experiment, but have proved very satisfactory. They have enabled the district to get settled men for principals of their school, and have helped them to hold these teachers for a series of years. They have also found that the school property has been much better cared for by having a teacher living on the corner of the grounds where he can see after it. The school property has been kept up in a much nicer shape. I think it will be an excellent thing if we had a law permitting boards to spend the district funds in this way. At present there is no law for it in Oklahoma. (L. L. Sturgeon, County Superintendent, Wewoka, Okla.)

Oklahoma.

Hughes County reports five teacherages that are proving quite a success but in some of them the teachers are required to pay rent. One teacher's cottage is reported in Pittsburgh County in District No. 27.

In Antlers County one district has a house for the teacher and the reason for this house is as follows: "Several years ago the teacher had a good deal of difficulty in securing a house to rent. He finally built in the corner of the school yard, which was a large one, and at the close of school sold the building to the district. It has proved to be a great convenience and they have no trouble now in getting a married man for a teacher. The school is located in a small village."

Seminole County has two teachers' cottages in the rural districts and the plan is proving very satisfactory. In one instance this year the teacher has spent all his odd time during the school term and during his vacation time in keeping the school ground in shape. One of these districts pays $75 and $50 for teachers, the other $90 and $60. In each instance the house is furnished the teachers free.

Garvin County has two homes in the rural district schools and in each they furnish the fuel the same as they do for the regular school building. If the teacher does not occupy the home, an amount equal to the rent is deducted from his salary. The question of board is a very hard one to solve. The only reason they have no more homes in this county is because they have not the money to build them.

Three cottages are reported in Laflore County. In Jackson County two common school districts have cottages which are rented to teachers. "These cottages solve the problem of a boarding place for the teachers. They aid the district to secure married teachers which is very much desired by some districts. The teacher can better care for the school property, vandalism is reduced to a minimum, the teacher can do the janitor work and is always on time. There is no loitering on the school grounds after hours. There is no jealousy because a certain family boards the teacher. The teacher remains in longer periods of service and longer hours of service. The teacher can economize to suit herself. The cottage plan is satisfactory to us and I recommend it to school boards building new buildings as the house is cheaply constructed out of the old one."

Medill, Oklahoma, reports that four rural districts have built neat dwellings on the school premises for the purpose of having a teacher on the school ground during the entire term of school. The teacher pays $6 a month into the school fund of the district. Board in the rural districts is almost impossible. Johnson County has one cottage and this district is most sought by the teachers in the county. The people of the district consider it a good investment. Marietta reports three rural districts in the county that have constructed teachers' cottages. The plan works admirably as many districts prefer men teachers who have families and the districts with teachers' homes have that advantage over those that have none. Some schools fail to get teachers because they cannot get a home.

Jefferson County reports one rural district, a "live one," in a two-teacher school where a neat cottage has been erected as a home for the teacher. Immediately there were a number of successful teachers applying for this school. This is the first year for this in this community. So confident of the merits of the measure is the superintendent that he proposes to advocate it in several school districts of the county.

In Kiowa County two such homes are found. They are in consolidated districts and in both cases the houses are reconstructed old school

Teachers' Cottages in Seminole County, Oklahoma

buildings. The cottages are neat and homelike, although small. The superintendent states that he has had the pleasure of taking dinner with each of these teachers when visiting the schools. In one the home is furnished by the teacher and his family, in the other the home is furnished by the janitor and the teacher boards with his family.

"Only one district in this county, McCurtain, owns a house for its teachers to live in. This cottage is rented by the school board to the teacher of the district. We are just introducing this plan hence do not know how successfully it will work. The problem of suitable boarding places for teachers in this new county is a serious one. In some instances teachers have given up their schools on account of not being able to obtain suitable accommodations in the district. It is our plan to induce the districts in this county to purchase from five to ten acres of land, which is now very cheap, near their school sites and to erect thereon cottages for their teachers to live in, the plot of ground of five or ten acres to be used for experimental and demonstration work. In this way it is believed teachers can be induced to remain for a number of years in their positions and thus become leaders in the rural life of their respective communities. Living on the experimental farm adjacent to the school premises, they will be able to care for the district's school property, and attend to the giving out of library books. We believe this plan, if properly carried out, will result in filling our schools with more mature teachers, perhaps married people, who wish to remain in the community and thus become identified with the rural life in their respective communities." (U. S. Bureau of Education.)

Oregon.

There has been but one teacher's cottage built in Josephine County. This is at Grants Pass, Dist. No. 7. Size, 24′ x 34′—one-story. Wood studding, lathed and plastered, set on cement foundation. Five rooms. Bathroom, toilet, two closets. Cost, $1,000. (Lincoln Savage, County Superintendent, Grants Pass, Ore.)

* * * *

In response to your inquiry concerning teachers' cottages, etc., will state that I am in hearty accord with the idea. So far, we have but one three-room teacher's cottage in this county, which is serving a very good purpose both to the teacher and the district. I should say that it is worth $25 a month to the district, and did not cost to exceed $300. It is continuously occupied. We shall have more of them. (J. W. Allen, County Superintendent, St. Helens, Ore.)

* * * *

No teachers' cottages have been erected in this county. In three districts cottages are provided for the teachers by renting, but none have been built by the districts. (S. E. Notson, County Superintendent, Heppner, Ore.)

* * * *

In Monroe County, District No. 36, the house is furnished free to the present teacher who is a widow with three children. Without this house it would be impossible for any teacher to find a suitable boarding place and the district had agreed to furnish a house if a teacher could be secured for them. In District No. 8 a new two-room schoolhouse has been completed. The board is fitting up the old building as a cottage for the principal. In District No. 19 last year a house was furnished free to the teacher. She was a lady with three children of school age and the district needed these children to give them the needed apportionment. The house was an unoccupied farm house and no charge was made by the owner for rent. The County Superintendent is advocating the employment of teachers during 12 months of the year. During the vacation period, the teacher can direct the industrial work of the pupils. This will require the furnishing of a cottage. (U. S. Bureau of Education.)

Pennsylvania.

I know of no place in which the school board has erected cottages for teachers to live in. In my opinion a school board would be allowed to do this and thus pay for part of the teachers' compensation.

The State, several years ago, erected a school building with a home on the Cornplanter Indian Reservation. This has been quite successful. (Nathan C. Shaeffer, Superintendent of Public Instruction, Harrisburg, Pa.)

* * * *

In the township high schools, Waterford Borough provides rooms partly furnished in an old academy building for the teachers. Two of the County Superintendents wish there were teachers' cottages in their county. Two more trust that the movement may spread. (U. S. Bureau of Education.)

Rhode Island.

No cottages reported from Rhode Island. (U. S. Bureau of Education.)

South Carolina.

A considerable number of South Carolina school districts have erected teachers' cottages. This work in the neighborhood depends absolutely upon local sentiment and local conditions. Such a cottage is permissible under the law wherever school funds can bear the expense. (J. E. Swearingen, State Superintendent, Columbia, S. C.)

The Teachers' Home at Pleasant Hill, Hamer, S. C., was an old church, which was repaired and remodeled. (T. H. Watson, Council, N. C.)

* * * *

We have a cottage, which is used by the superintendent of the schools, valued at about $3,000. It has four rooms downstairs and three rooms upstairs. The rooms are something like 16 x 16 feet. We have electric lights and water, and the old southern fire-places. What I think we need is a boarding hall for teachers. (D. R. Riser, Superintendent City Schools, Manning, S. C.)

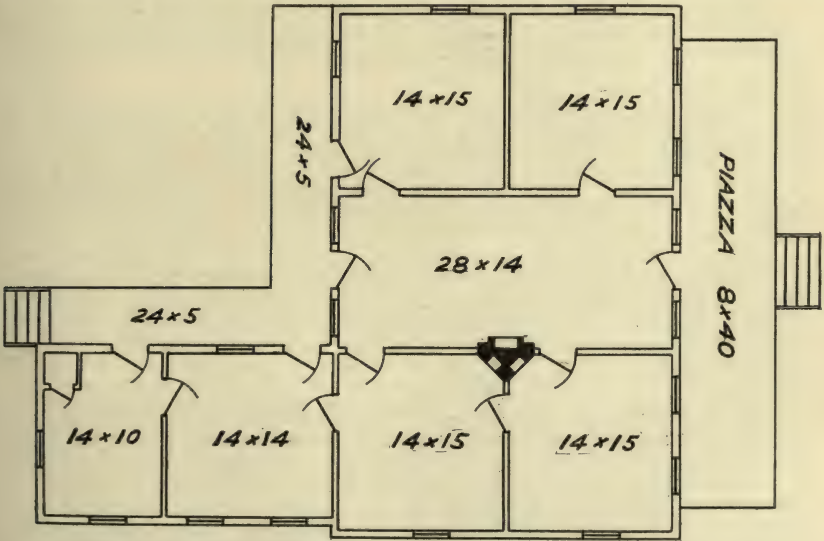
* * * *

Our school is perhaps a little different from most schools. It is located in a historic section of Anderson County. We have 125 acres of land in connection with our "Teachers' Home." Now in regard to size and construction: We have a six-room cottage, a long hall with three rooms on either side, a fire-place in all rooms except one, two rooms very small, the others fairly comfortable. I am a teacher in this school, and if you will pardon me for the suggestion—I would advise a house without a hall. We use our hall very little. Often wish it was a room. The "Teachers' Home" is a great thing, especially in the rural communities, where it is so hard to get board. Our great trouble here is getting some one suitable to run the house. (Cora E. Haddon, Liberty, S. C.)

* * * *

The "Teachers' Cottage" here is a frame building, ordinary weather boarding and inside ceiling of the usual beaded ceiling; inside height about 12 feet, shingle roof. Painted white, with interior painted a light oak, overhead blue.

The cottage was made from the old schoolhouse that was on the ground before the consolidation of the schools of the District, and the erection here of a nice brick school building. The old building contained two large rooms with a narrow hall of about eight feet. This hall was made wider, and the



Floor Plan of Teacher's Cottage, Mars Bluff, South Carolina, Remodeled from Old Schoolhouse

South Carolina.

Residence Furnished City Superintendent of Schools, Rock Hill, South Carolina

two large rooms divided with partitions and the two rooms built new, and the back piazza. The old school building cost about $700 and the remodeling about $600. (See floor plans, page 47.)

I consider the home very well suited for its purpose except for the lack of closet rooms. We teachers find the home quite convenient, and the Trustees and patrons are well pleased with the arrangement. (W. Y. Boyd, Principal, Mars Bluff, S. C.)

* * * *

This is the only city school in the State that provides a home for the superintendent. Quite a number of the country districts and villages do this, but Rock Hill is a town of about 12,000 population with about 2,000 pupils in all the schools.

The home was built quite a great many years ago, perhaps 20 years ago. It is a two-story wood structure, with nine rooms, front and back halls, front, side and back porches. (See illustration above.) The rooms are each about 15x15, except the kitchen, which is about 10x10. Bathroom with hot and cold water is upstairs. There is a large back yard and a large garden space, a good wood house, and a barn for horse and cow, etc. It is adjoining the Central school where I have my office.

The Board has found that it is a good investment. In arranging the salary the home is usually estimated at about $300 per year. The superintendents find it a great convenience not to have to look out for a home. Altogether, it seems a splendid plan for all concerned, and I think that other city schools would find it a good investment. (R. C. Burts, Superintendent Public Schools, Rock Hill, S. C.)

* * * *

Several years ago the Eastover District consolidated with several neighboring districts, forming a graded school, using five hacks to bring the children to the school. The old school building was moved and remodeled into a commodious teachers' home of nine rooms. The home is nicely ceiled throughout, with front and back piazzas. The doors and windows are all screened, all windows also having blinds. The home is nicely painted inside and out. The home is located on two acres of ground very near the schoolhouse. There is a demonstration plot, a shed for wagons and stock and a basketball ground.

The greatest good of the teachers' home is that it has in a large measure, eliminated the constant change of teachers, which is death to any school. This idea carried out will revolutionize the educational interests of any community. Teachers that remain for years become more and more identified with the best interests of the community.

May the day soon come when every community can have its own teachers' home right on the school grounds. I bid you God's speed in promulgating this idea. (B. M. Cheatham, Eastover, S. C.)

* * * *

One in a district in Marlborough County and one in Pickens County. County superintendent wishes he had more.

Farlington County reports that the servant question is becoming so serious in the South, that many of the women have to do all their own work, which makes it impossible for them to keep boarders, particularly if there are children in the family. These conditions are worse in the country than in town. One teacher reported that he would have to canvass the district again for a boarding place. Board obtained under such circumstances is a source of humiliation to the teacher and its effect too is felt on the feelings of the children toward the teacher. It makes them feel that teachers are inferior beings permitted only on sufferance to live in their homes. For the first time this year Darlington County will have three teachers' homes in connection with the public schools.

Dillon County will open their first teachers' home in one of the rural schools of the county. It is an old schoolhouse remodeled, painted, plastered, etc. A new schoolhouse has taken the place of this old one. This teachers' home will fill a long felt want in the community on account of the boarding proposition. All schools in the county will be forced to furnish homes for teachers.

Lancaster County has one for a colored school which gives the superintendent a home in the school dormitory. It is a growing sentiment, even in the rural districts, to prepare a home for the teacher in each district in order to keep the teacher in the community the year round, especially to look after the demonstration plots, the boys' corn clubs and the girls' tomato clubs. (U. S. Bureau of Education.)

outh Dakota.

South Dakota has no law authorizing common school districts to build teachers' cottages. It would probably be a good thing for the state if we had such a law. However, the consolidated districts may build a teachers' residence, and some of them are already doing so, but we have no such provisions as the State of Washington has for the building of cottages. (C. H. Lugg, Superintendent of Public Instruction, Pierre, S. D.)

* * * *

Charles Meek County. The school board in Kennedy Township paid for an addition to be built on to a small house, so the family living there might board the teacher. This addition then belonged to the house where built.

Corson County. A room has been built in connection with the schoolhouse in one of the rural communities, where the larger proportion of the population are Indians. This is to accommodate the teacher. It is not large, but the county superintendent remarks that it will do better than driving miles in the storms that we are so apt to have in this country. (U. S. Bureau of Education.)

ennessee.

Irvin reports that it would be a great blessing to the schools if there were some teachers' homes. So often the teacher cannot get board at all satisfactory and sometimes they could not hold the best teachers for this reason. We have three such cottages owned by missionary boards where the teacher lives and it works fine.

Tennessee.

The boarding proposition is making the teachers' cottages a necessity. (Elm Wood.) Johnson County has some dormitories for the high school. "Hope the time will soon come." High school board furnishes principal of Dayton, Rhea County, with a home.

Knox County furnishes cottages to each of the principals of the five agricultural high schools. It keeps the principals the year round and they also furnish them a helper on the farm of 15 acres. They find the plan works very well, in fact, is the only way to build up a community center about a school. "Our grammar schools have not been able to furnish homes, but expect to try this out in one or two consolidated schools next year."

London County has one cottage furnished the principal free. This proved a great convenience for the principal this year.

Fayetteville supports three buildings occupied by the teachers, owned by local school boards, but a small amount of rent is demanded for each building. A nice garden lot makes these buildings very desirable.

Lawrence County reports one teachers' home in connection with the county high school. The principal looks after the demonstration plots. The plan works admirably.

Trenton County superintendent has advocated and urged that "pedogogians" or teachers' cottages, be built for many of our schools for the reason that oftentimes it is impossible to rent a dwelling house or get board in many country communities. (U. S. Bureau of Education.)

Texas.

Many of our rural schools are building houses for their teachers. The next Biennial Report of the State Superintendent of Public Instruction of this State will contain data relative to this subject. (W. F. Doughty, State Superintendent, Austin, Tex.)

Typical Teachers' Cottages Near San Antonio, Texas

Two teachers' cottages in this county; one a two-room cottage, the other a four-room cottage. (E. R. Haynes, County Judge, Lubbock, Tex.)

* * * *

Teacher's cottage built at Alief in District No. 46. (J. W. Lyle, County Superintendent, Houston, Texas.)

* * * *

We have fourteen teachers' cottages in the rural districts. They are three and four-room frame buildings. The best of them are built with 4 rooms, 14 by 4, with hall running through. They have front porch and screened back porch with pantry on one end and bathroom on the other. The cost in this county is about $1,000. (Typical cottages are shown on page 50.)

In most cases we have a garden of from 1 to 3 acres with each cottage. We find that we can get and keep better teachers where they are provided a place to live. (P. F. Stewart, Superintendent of Public Instruction, San Antonio, Tex.)

* * * *

As to what I think about teachers' cottages, I must say that in my opinion, and it has proven itself in my county, that the school can have no greater asset than a teachers' cottage on the school campus in connection with a large school garden as a part of the school equipment. (Typical Walker County views are shown on page 52.)

It is an easy matter to get first-class married teachers for our schools where teachers' cottages are provided. And when once they are located, they stay with us during the vacation, and look after the school buildings and grounds, and become real active citizens of the community.

Forty-five per cent of the teachers in Walker County, Texas, are Normal School graduates, about forty per cent hold State First grade certificates, and fifteen per cent other class certificates. Every teacher in the county has had professional training in a Normal school for teachers. This applies only to the white teachers. (J. C. Thomas, County Superintendent, Huntsville, Tex.)

* * * *

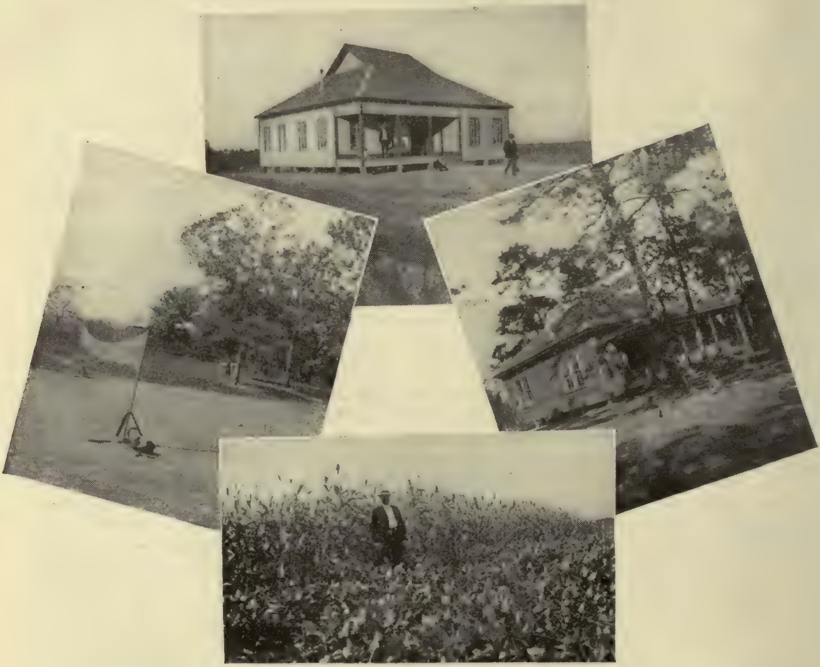
Harris County rents a teachers' home for the superintendent and the teachers board with the superintendent at $20 a month. Several county superintendents report that the plan attracts teachers who in turn protect the school property. Twenty-two counties support 72 cottages. Two are not used because they could not secure married men. One county reports they have kept the teachers three years on account of the cottages. Another reports that they have more applications for the position of teacher where they have a home. One cottage has already paid for itself by renting it to the teacher at a very nominal sum.

Coleman County has remodeled an old school building in one of the rural districts and furnished it for the teacher, and the teacher is more than pleased with it and looks after the school property. Twenty cottages are used in Comal County, rent free.

In Medina County in two districts, the old schoolhouses have been remodeled and made into very neat and comfortable teachers' homes. The county superintendent reports, "It is a splendid idea for the rural school districts and the Yancy High School has two teachers' homes, one for the superintendent's family, and one for the three lady assistants. Labaca County reports 13 teachers' cottages that are furnished free to teachers and their families, and that they are all located in German and Bohemian communities in the rural school districts. Lubbock County reports two teachers' homes for rural teachers. The county considers them quite a help to the community that prefers a married man or woman to teach. They are given rent free.

Bosque County reports one that is a great success and regrets that they do not have them all over the county, as the county superintendent feels that they will solve a great many of the rural troubles. They will prepare

Texas.



Teachers' Cottages Costing $500 to $750, Playground and School Garden, Walker County, Texas

to build more. Portland County reports one district with a five-acre plot of ground, a one-room schoolhouse, a neat cottage of three rooms with necessary garden, stable, etc., and that they have an excellent young married man as teacher for $75 per month for eight months. His house rent and garden is free. The superintendent likes it and wishes more districts would adopt the plan.

Wood County reports two cottages connected with secondary schools and that the plan works well. Benton County reports one in a consolidated district which was recently built. Falls County reports one that will be occupied this year. Milam County reports four furnished, rent free to the teachers and that the plan is more satisfactory. "The teachers are retained longer and hence are more useful as citizens. We are encouraging our people to erect more cottages." Victoria County reports one cottage not being occupied because men with families can do better than teach school. "Four cottages are used in Bell County by the teachers as residences. The plan is a signal success. Teachers with families have charge of these schools. The residences are an inducement and the best teachers are contracted for these schools. I believe it a very profitable investment in any school where more than one teacher is employed." Lee County was compelled to build a teacher's cottage in one district on account of scarcity of houses. "School funds were used for its construction. The people were agreed with the idea as they understood a proportion of their tax money was to go for payments on this residence as well as for the schoolhouse. The residence being a permanent fixture, enables us to secure the services of more capable men for the school. We find we can receive more applicants for the principalship of that school than for any other place of corresponding value. The principal applying for this school is guaranteed a residence with the rent determined."

Van Zandt County has three such cottages. The first one was built about five years ago from funds loaned by a patron in the community. He is to be paid back from rent on the cottage paid by the teacher who occupies it. The teacher pays $10 per month. The cottage is located on the campus. This school employes two teachers. The plan is popular. The last year before this cottage was built, the teacher who was a married man, could not get a home in the community, so he drove eight miles each morning and afternoon in going from his home to the school. Another was built years ago by the community from money donated by the citizens. The teacher pays a small rental here and they are enabled to get a married man for principal. This school employs three teachers. The third community has just finished a cottage erected by funds that were left from a bond issue after erecting a two-room school building. The teacher will pay a small rental here. The community has employed a married man as principal of the school. Two years ago they had a married man who could not get a home in the community, so he rode a bicycle six miles and back each day. He rented him a cottage in a town of about 2,500 inhabitants, which was six miles from the school. The plan has proved a success in each instance in this county where it has been tried.

Hall County reports four common school districts furnishing cottages rent free to teachers and every place is proving successful. "Teachers stay more than one year at these schools and are better satisfied. The cottages are near the schoolhouse and school property is not molested on that account. Our cottages are remodeled schoolrooms and are in districts where new school buildings have been built. The old school buildings are usually sold for a song, but with a small outlay can be made into comfortable cottages. I consider them worth a great deal to a community in class of teachers this feature attracts." Hopkins County reports one built by private subscription and rented to the teachers at a reasonable rate per month. The proceeds are used for the further maintenance of the school. The district has owned the house for eight years and the rent has more than paid for same. The district has been able to secure better teachers and more experienced teachers than they otherwise could have done. Scurry County reports one cottage in district No. 10. The house was purchased by the district and placed upon the school site so that the district would always have a convenient home for the teacher. Seymour County has two teachers' cottages and claim it pays. (U. S. Bureau of Education.)

tah.

Such a plan would prove a great stimulus to the rural schools. Jordan consolidated district has just completed a six-room modern cottage for the principal of the high school on the high school campus. This is furnished to the principal free of charge. Two other cottages are built on this campus for which low rental is charged. Carbon County reports three teachers' homes erected by the school board, but for which a reasonable rental is charged. Four or five teachers usually occupy these cottages and in some instances they have a housekeeper to do their work. The erection of these cottages has the effect of making the teaching force more permanent. (U. S. Bureau of Education.)

ermont.

Very little seems to have been accomplished in Vermont, but one superintendent says, "I have taught for 17 years and can say that I have had all sorts of trouble in securing a place either for boarding or for housekeeping. I think you have a good idea and hope you will bring something out of it." (U. S. Bureau of Education.)

Virginia.

Five county superintendents report it very difficult to secure good boarding places in their county. Lunenburg County is impressed with the plan and is putting forth an effort to build some this coming year. Fluvanna County regards the suggestion as a good one. Henrico County thinks the time will soon arrive when we will find it absolutely necessary to have it. An agricultural high school near Appomatox furnishes the teacher in charge with a home. Albemarle County reports it is almost impossible to secure decent boarding places for teachers in some instances. Spottsylvania and Stafford state that teachers' cottages are well worth considering when the difficulty of securing good board is so great. In Wise County, in the mining town of Sutherland, where it was hard to get board for teachers, they fitted up a room on the second floor so that the two teachers could board themselves and stay in the building. Williamsburg has plans on foot for a school cottage to be used by the colored teachers for teaching housekeeping, cooking, etc., as well as a home for these teachers. (U. S. Bureau of Education.)

Washington.

Washington is yet far in the lead in the number of teachers' cottages. More than 100 cottages have been built and they are popular everywhere. (Pictures of four cottages are reproduced on Page 55.)

The provisions of the Washington law on this subject are as follows:

COMMUNITY PURPOSES—BUILDINGS.

"460. Wider Use of School Buildings—Erection of Teachers' Cottages—That school boards in each district of the second-class and third-class may provide for the free, comfortable and convenient use of the school property to promote and facilitate frequent meetings and association of the people in discussion, study, improvement, recreation and other community purposes, and may acquire, assemble and house material for the dissemination of information of use and interest to the farm, the home and the community, and facilities for experiment and study, especially in matters pertaining to the growing of crops, the improvement and handling of live stock, the marketing of farm products, the planning and construction of farm buildings, the subjects of household economies, home industries, good roads, and community vocations and industries; and may call meetings for the consideration and discussion of any such matters, employ a special supervisor, or leader, if need be, and provide suitable dwellings and accommodations for teachers, supervisors and necessary assistants.

461. Districts May Erect Communal Assembly Place—That each school district of the second- or third-class, by itself or in combination with any other district or districts, shall have power, when in the judgment of the school board it shall be deemed expedient, to reconstruct, remodel, or build schoolhouses, and to erect, purchase, lease or otherwise acquire other improvements and real and personal property, and establish a communal assembly place and appurtenances, and supply the same with suitable and convenient furnishings and facilities for the uses mentioned in section 1 of this act.

462. Commission to Pass Upon Plan—That plans of any district or combination of districts for the carrying out of the powers granted by this act shall be submitted to and approved by the board of supervisors composed of seven members, as follows: The State Superintendent of Public Instruction; the head of the extension department of Washington State College; the head of the extension department of the University of Washington; the county superintendent of schools of the county in which such facilities are proposed to be located; these four to choose a fifth member from such county, and a sixth and seventh member, one of whom shall be a woman, from the district or districts concerned."

Cottage at Blue Creek, Walla Walla County

Cottage at Snoqualmie—Five Rooms, Electric Light, Hot and Cold Water, 'Phone, Motor-Driven Washing Machine

Small Cottage, Valley Grove District, Walla Walla County

A Double Cottage

Typical Teachers' Cottages in the State of Washington

Washington.

The following expressions of opinion from county superintendents in Washington, quoted by Mrs. Preston, speak for themselves:

"They seem to be a necessity in these districts. I believe it will be a step toward better harmony in the districts, better homes for teachers, and better school work because of comfort, independence, tenure, etc." (Delia L. Keeler, Whatcom County.)

"I believe it is the solution to many of the rural school questions. It will give the services of teachers who will feel that they are a part of the community in which they live. Many teachers 'stay' in the community, but few really 'live' there." (Wm. U. Neely, Lincoln County.)

"Much better teachers can be obtained for less salary; teachers who wish to live in a cottage usually are more anxious to understand the community and its problems as well as its opportunities; they are much more likely to remain in their positions as they grow more necessary to it." (Mrs. Lena Kohne Pratt, Island County.)

"It is one of the great factors in the solution of the problems of the rural school. It aids in securing a more permanent position; gives the teacher privacy and independence; and affords more liberty in acknowledgment of social duties." (Mrs. Lizzie Jones, Snohomish County.)

"One of the best investments that a school district can possibly make. It tends to make the teacher more permanent, helps both teacher and school in the matter of social center work. Every rural school should possess one. One clerk tells me it was sort of an experiment, as the teacher had such a hard time finding a boarding place. The plan worked fine, and he now says: 'We would as soon think about getting along without the schoolhouse as the cottage.'" (O. H. Kerns, Skagit County.)

West Virginia.

There is a cottage on the school ground at Sherrard. It was the residence of the owner of the property, purchased for the Sherrard Consolidated and High School. (Illustrated below.)

The cottage was used by the first principal, 1911-12 and 1912-13. In 1913-14 one of the high school teachers and her brother (a student) kept house. Since 1914, it has been rented to a merchant for residence, but he

Consolidated School and Teacher's Cottage, Sherrard, West Virginia has been asked to vacate, and it is the plan of those in charge to make the cottage more serviceable to the school. Probably two of the high school teachers will use it the rest of the year.

The cottage has been of no special benefit to the school so far as getting and keeping better teachers. It should be, and I think the time is near when every school will have a home for the teachers. (A. F. Shroyer, Principal, Consolidated and High School, Sherrard, W. Va.)

* * * *

Two of the county superintendents state the boarding proposition is a serious one with them. One of them remarks he "never heard of such a thing." Two county superintendents "only wish we could report some." Two others reply that they think it is a good move. The union district at Sherrard has a five-room cottage. It is one of those communities where each man lives in his own house and no man has one for rent. They have owned this cottage for four years. The following very interesting experience is related: "The first principal of the school was a married man with a family of four. It was just suited to his needs. He had one-eighth acre of land for a garden, where he worked out some valuable lessons in agriculture and fruit budding and grafting. Unfortunately, he died at the close of his second year and a single man was hired to fill the vacancy. The latter did not have any use for the house, so it was rented to an outsider at eight dollars a month, a fair return for the investment. Since that time it has been occupied, but we still hold it in reserve for the future, when we may hire a married man." (U. S. Bureau of Education.)

Wisconsin.

Difficulty of securing good boarding places is mentioned by several of the county superintendents. They expect to build a teachers' home in Polk County. Some of the superintendents state they must develop some plan soon to relieve the situation. One wishes they had cottages now. (U. S. Bureau of Education.)

Wyoming.

As yet Wyoming has nothing to report in the matter of erection of teachers' cottages. The subject has been under discussion somewhat here and doubtless it will not be long before it will be necessary to follow the example of some of the other states in this regard, but so far the practice has not been put into use in this state. (Edith K. O. Clark, State Superintendent, Cheyenne, Wyo.)

REFERENCES.

Some of the more important articles upon the subject are:

Teachers' Cottages in Washington. Josephine Corliss Preston, Bulletin No. 27, 1915. Olympia, Wash.

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YOUR GARAGE

By

CHAS. R. W. EDGCUMBE

Price, Ten Cents

PUBLISHED BY
The National Lumber Manufacturers Association
TRADE EXTENSION DEPARTMENT
CHICAGO

NOVEMBER, 1916

GENERAL SERIES No. 52

"A good garage is as necessary as the car itself. It protects the investment in the car, and is a decided asset and selling advantage for any property."

Your Garage

Chas. R. W. Edgcumbe

This country of ours is fast approaching the day when most families will be the more or less proud possessors of a motor car of some kind. When one stops to consider that the output of one factory alone during the past twelve months was more than five hundred thousand cars, this statement can be readily believed. There is today in the United States one pleasure car for every sixth family, while even six years ago there was not one car for every fiftieth family.

Today the motor car is America's biggest institution, and is still growing by leaps and bounds. It has passed through its infancy and is now only in its early youth. In its infancy it had a very hard time of it. After birth, its life was despaired of, it contracted every ailment that machinery is heir to, but it survived them all and now has a most vigorous and lusty constitution.

I claim that everyone should own an automobile of some sort. The automobile in the summer months, in fact, practically the whole year round except in the very cold weather, in a large measure takes the place of the living room of your home. It takes you and your family out into the open air, which means greater health. It pays for itself, both in first cost and future upkeep expense, in greater pleasure and smaller doctor bills. Merely as a means of rapid transit from one place to another, its place will never be usurped unless it be by the complete mastery of the air. True the Air Age is fast approaching, but the Motor Age is here and is here to stay. Everyone is afflicted with the disease of motoritis. This used to be the malady of the rich, but the disease is so infectious that it has taken hold of us all and those who have it not are in the hopeless minority.

Housing the Motor Car.

Second only in importance to the building of your home is the building of your garage. Time was—and not so very far distant at that—when anything that had four walls and a roof to span them was considered sufficient for the average car. Today that is all changed as it should be, since it is an established fact that the better you treat machinery, whether it be farm machinery or automobile machinery, the better it will treat you.

Adequate housing for the car you now own, or hope to own in the future, is an absolute essential. Most people are under the impression that building a garage is an expensive proposition, but this I hope to disprove. Of course, a garage can be built as expensively as desired, but just as serviceable a building can be erected for an amount well within the means of the man who can afford to invest in a motor car. Adequate care means a long lived car and one on which the upkeep is minimized.

Where money is no object, the garage can be built in conformity with the architectural lines of the most elaborate home—can be built with materials that are very costly—but the object of this little book is to show how a garage that will provide adequate housing for the average motor car owned by the average man can be built at a very reasonable cost.

What man is there among car owners that cannot get a world of pleasure out of the care of his car?

Personally, I can get more real enjoyment by donning a jumper suit of overalls and with grease gun, oil can and kit of tools, going over the little old car from bumper to tail light, than a Pittsburgh millionaire can get out of his ocean going yacht. And I am just about the same type of human being as the average car owner. Looking after your own car takes your mind off business cares and worries, produces good healthy flesh, and hard muscles.

The little garage on the back of the home lot makes this possible.

Garage Essentials.

In erecting a garage it is poor policy and even poorer economy to forego a few essentials to save a few dollars in initial building cost. I believe that practically every garage built should have as equipment:

1. A pit which enables you to get under the car with ease. This costs practically nothing extra and is well worth having.
2. A gasoline tank installed underground just outside of garage, with pipe and pump inside. The added cost of this equipment is soon taken care of through the saving effected by purchasing gasoline at wholesale rates.
3. A work bench. This can be built 6 feet long and 12 or 16 inches wide with one piece 2x6—or 2x8—12′, cut in two, supported by a framework of 2x4's.
4. Plenty of shelf room.
5. A water connection if possible.
6. A drain with sewer connection at bottom of pit, with floor sloping from walls to edge of pit about 2″.
7. Electric light connection if possible. Many put the light in the center of the garage. This is poor policy, as it is very inconvenient, especially when the top of the car is raised. It is a far better plan to have an outlet directly over the workbench. In this outlet have a two-way benjamin, one socket of which accommodates a stationary light, while the other takes an extension cord with trouble lamp attached. This

cord should be of sufficient length to reach from one end of the garage to the other.

8. Heating equipment of adequate capacity wherever possible. Serviceable garage heaters can be bought at a reasonable price.

Always build a garage as tightly as possible. In Northern climates where the thermometer registers many points below freezing for several months each year, it is advisable to sheathe the garage inside as well as out, and this in spite of the fact that you are going to equip with heating apparatus. With coal at its present price anything you can do to reduce the coal bill is 100% pure economy. To sheathe inside costs but a few dollars extra, which will soon be taken care of in decreased coal bills—even in the course of one cold season. Frozen cylinders and radiators are expensive propositions. Insure against them by building right in the first place.

In Building "Your Garage"

Remember:

1. Build right in the first place.
2. "Your garage" is an investment. Protect it and its contents.
3. A well-equipped garage is readily salable.
4. Wise building methods more than pay for their cost.
5. Use GOOD materials. Cheap materials are expensive in the long run.
6. A RELIABLE contractor invariably costs less than an unreliable one.

Illustrated herewith are a one-car and a two-car garage of simple, inexpensive construction and also a one-car and a two-car garage of more elaborate construction.

A Serviceable One-Car Garage.

On the opposite page is shown the plan for a good, serviceable one-car garage, which can be erected at small cost in any community.

The dimensions of this garage are large enough to permit the housing of practically any car manufactured. If desired, this building may be shortened, but it is advisable to build long enough in the first place. You will find that you never have too much room in your garage.

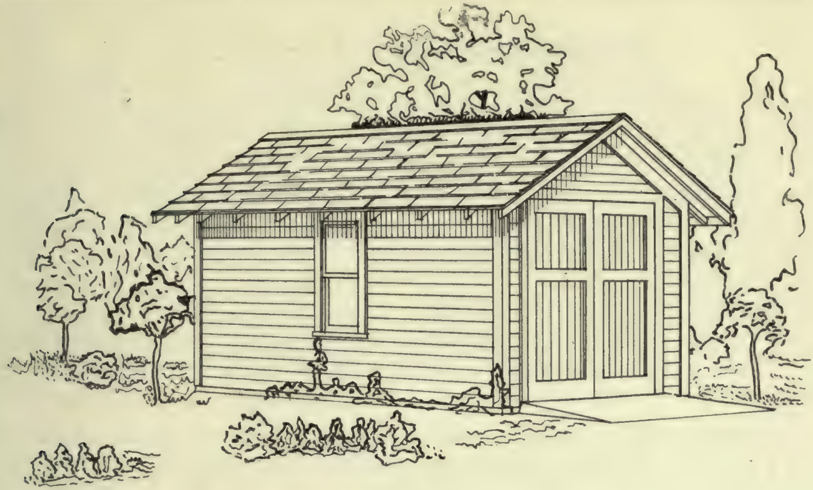
This building emphasizes real economy in construction. It is designed primarily for those who do not desire to spend any more than is absolutely necessary. In cold climates it is advisable to sheathe the building inside and out, and also to ceil overhead, although these may be omitted. In erecting the building use a durable wood or creosoted posts for foundation. Concrete or brick piers are good, but will add slightly to the cost and you will find that well creosoted posts will last as long as the garage is needed. The floor construction shown in the drawing is adequate and gives strength to the floor where it is needed most. The two stringers (two 2x6's spiked together) are directly under the wheels of the car as it stands in the garage. No other joists are necessary. The rafters and studs are spaced 3 feet apart. The floor is constructed of 2x6 planks, dressed on the upper side.

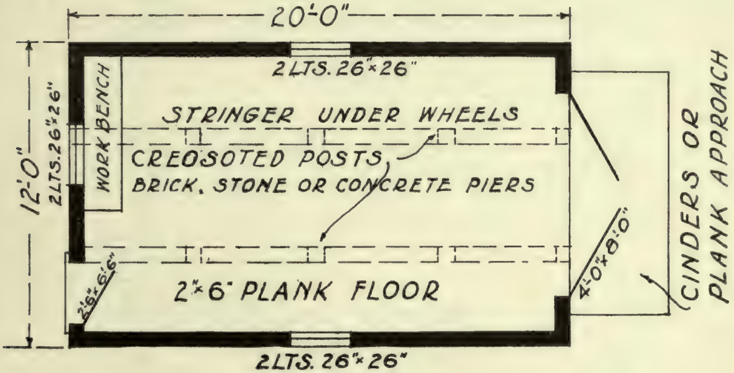
The dimension material and siding should be of No. 1 grade, but the roof boards may be a No. 2 grade. Shingles should be of first quality and on a small roof like this may be laid 4½″ or 5″ to the weather. Cut or zinc coated shingle nails should be used—not wire nails, which quickly rust out. The large doors are made of dressed and matched boards, four or six inches wide, as preferred.

Paint the roof and sides inside and out with a good grade of paint, preferably one that is fire-resisting. A white or gray inside paint makes the garage much lighter and adds greatly to the appearance. Use cement enamel paint on the plank floor so that oil and grease that drop from the car can be easily wiped up.

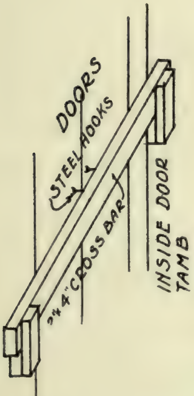
Get good hardware for the garage. A good lock is not easily broken or picked. Thieves gather where pickings are easiest.

Build this garage and then compare its low cost with what any mail order house offers. This building is not an eyesore. It needs but a coat of paint to make it harmonize with any building. It adds value and grace to your lot.

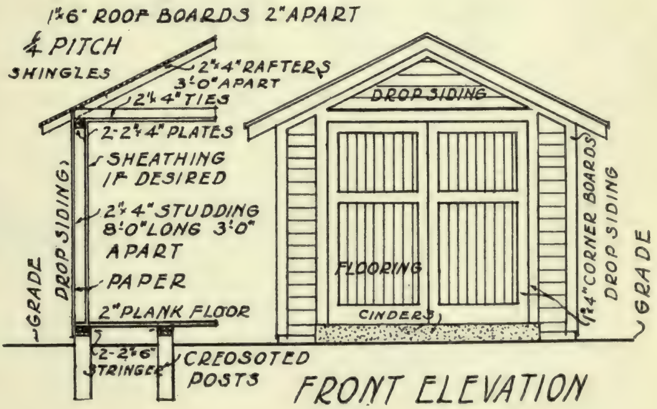




FLOOR PLAN



DOOR LOCK



FRONT ELEVATION

SECTION

A Serviceable One-Car Garage.

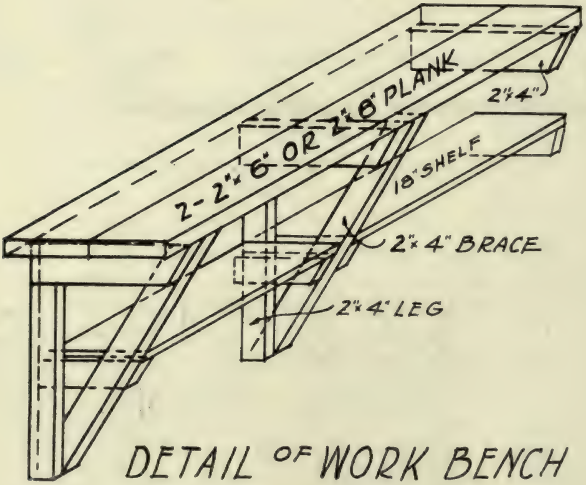
A Serviceable Two-Car Garage.

This building is designed for the man who owns two cars or one car and one truck. It can also be used to good advantage by the man who owns one car and who desires to rent one stall.

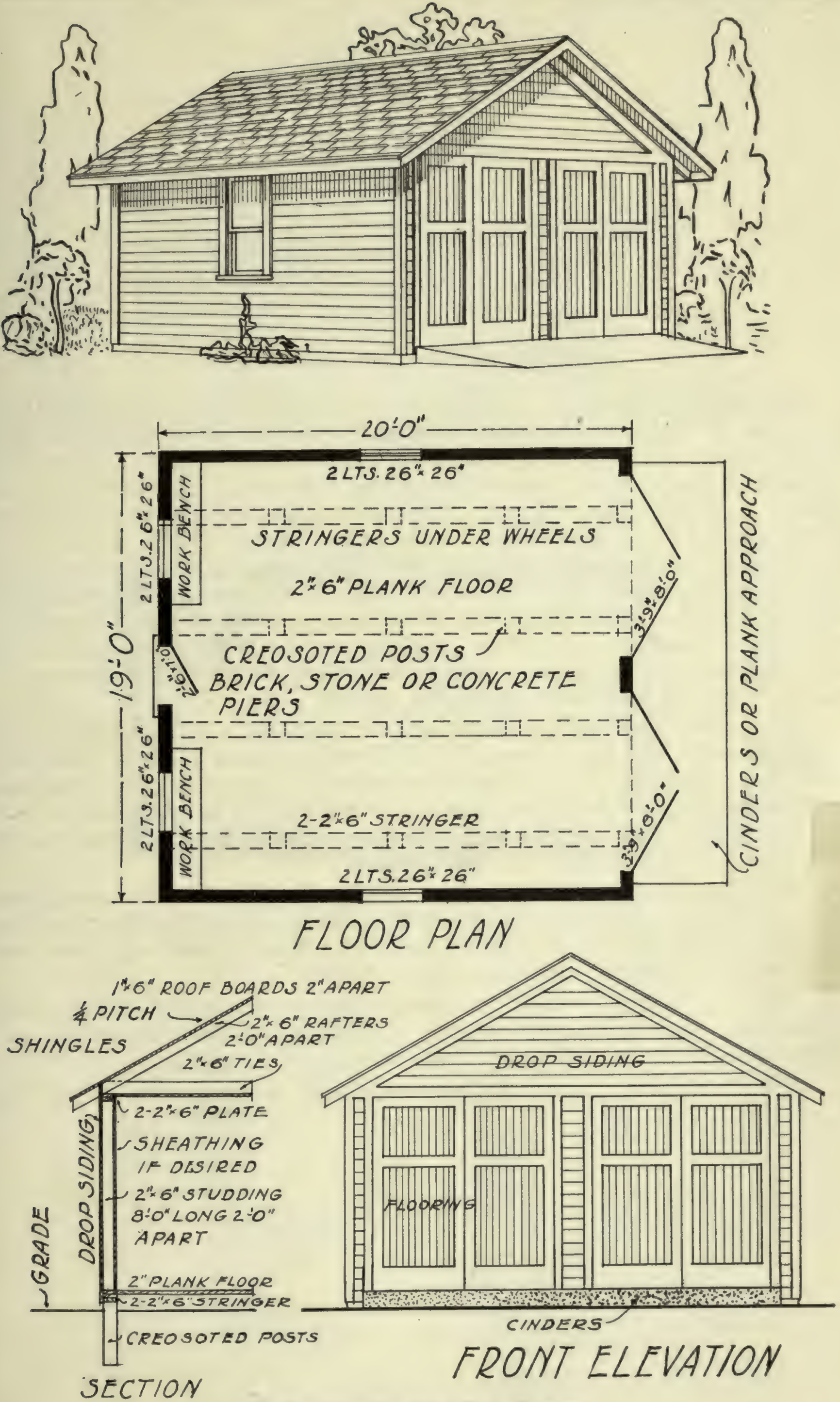
This two-car garage embodies the same economical ideas as the one-car garage described on page 6. Its construction is practically the same except that 2x6 studding and rafters are placed two feet apart to give greater strength.

By not partitioning, considerably more room is left for each car, although if necessary a partition can be placed in the center of the garage. This would, of course, necessitate two doors in the back of the building, instead of one as indicated in the drawings.

The construction of work benches for both this garage and the one described on page 6 is fully shown in the illustrations. Such a bench can be made quickly and at small cost by anyone who can use a hammer and saw and will be a constant source of satisfaction. Note that it is placed directly under a window in order to have good working light.



DETAIL OF WORK BENCH



A. Serviceable Two-Car Garage.

A Better One-Car Garage.

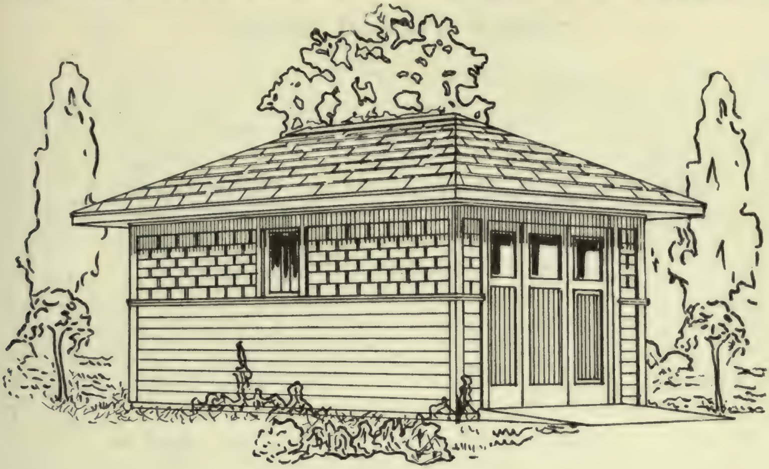
On the opposite page is shown a structure that embodies everything that goes to make a first-class garage. This garage is equipped with gas tank and pumping equipment, pit, work-bench, electric lights, folding sliding doors, water connection, sewer connection and heating apparatus. It is complete and will afford every convenience that is known to the garage building art and at the same time is within the reach of the average car owner. The gas tank and pumping equipment are as hard to estimate as is the heating equipment. One can spend practically what he pleases. The cost of the heating apparatus depends largely on the type of heater. It may be that the garage is close enough to the house so that a steam or hot water pipe can be run from the house equipment. This will materially lessen the cost.

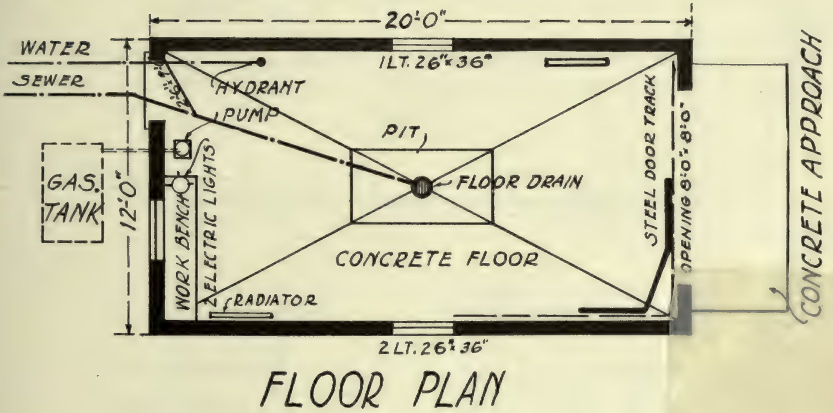
In smaller communities and farming districts the big doors of the garage usually face the house. This allows the car to be driven directly from the garage to the front of the home. In locating your gas tank and pump this must be taken into consideration. It is advisable to have the filling pipe for the gas tank (always outside the building) in the most convenient place for the tank wagon.

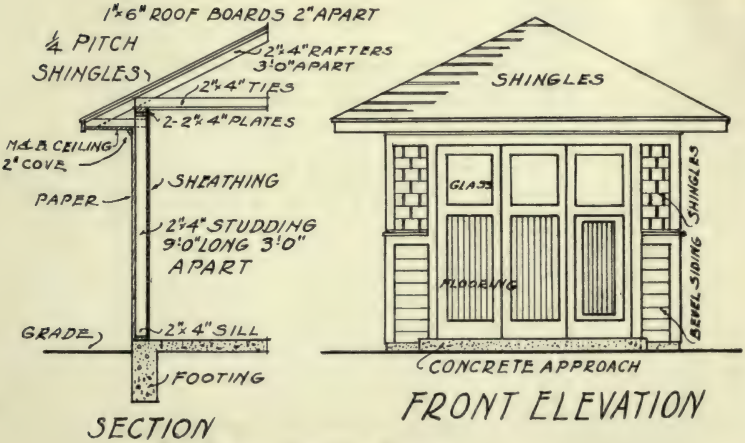
In a building of this type concrete footings and floors are appropriate. The general construction of this garage above the floor is along the lines of the previous descriptions. The large door is in three sections and slides back inside on a steel track.

The outside treatment of the garage is largely a matter of individual preference. Here we have shown beveled siding to the window line and above that, shingles. It makes a pleasing combination.

The construction of the pit for this garage is illustrated on page 12.







A Better One-Car Garage.

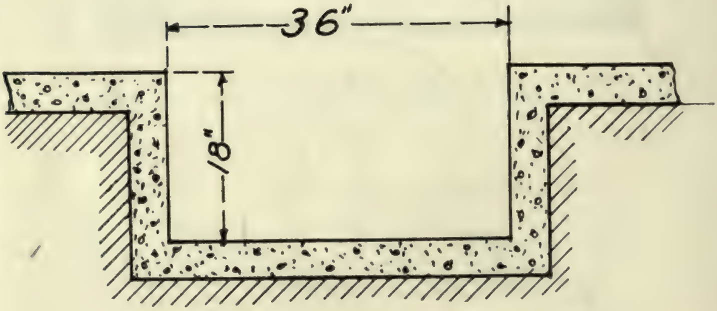
A Better Two-Car Garage.

This two-car garage embodies all of the features of the one-car garage described on page 10. The illustration shows a two-stall garage with partition between stalls. If you are the possessor of two cars the partition is superfluous, and only one door is necessary at the back. A door at both ends of the garage is really preferable, but the entrance door at the back can be omitted, as a small wicket door is shown in the large doors. Doors at both ends make better ventilation, especially when the motor is left running while standing in the garage.

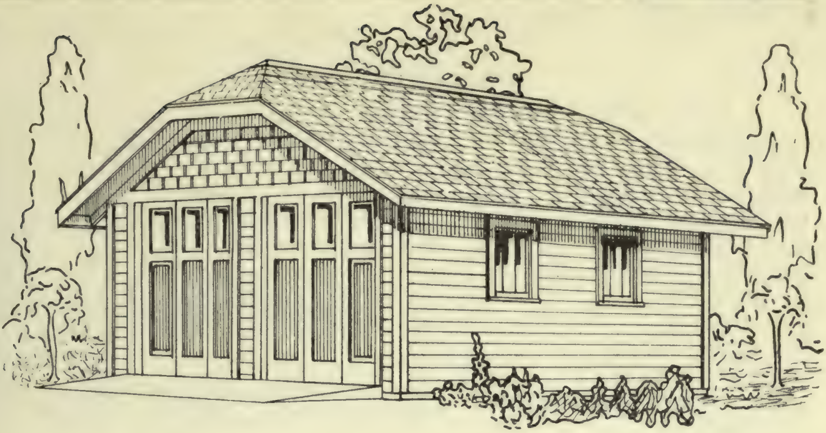
A case in the corner by the end of the work-bench in which to place tools, oil cans and accessories will be found very handy. Self-supporting work-benches on four legs should be built for this garage and the one described on page 10, since they are sheathed up inside and the studding cannot be used as with the bench illustrated on page 8.

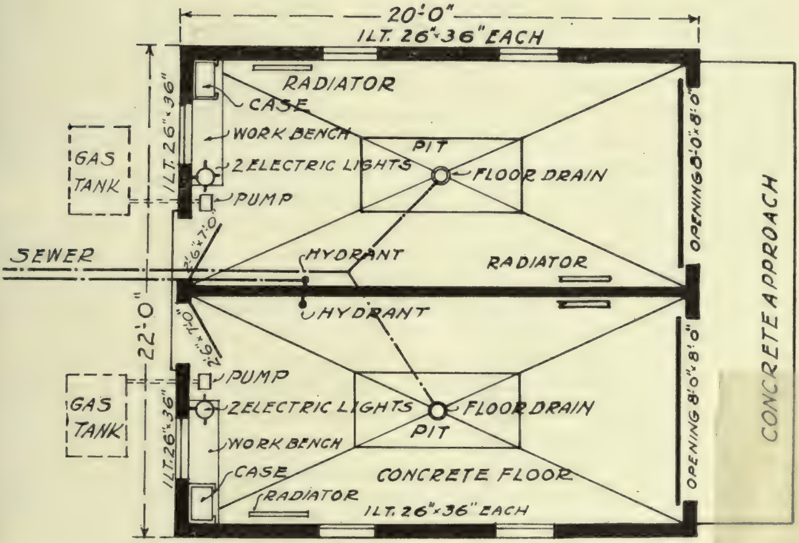
In heating a garage of this type put your radiators as close to the floor as possible, but be sure to get sufficient fall in the return pipes to the heater to assure the maximum heat. It is better to use wall or ceiling radiation if there is any doubt about fall enough with floor radiation.

Below is shown the construction of the pit for this garage and the one described on page 10.

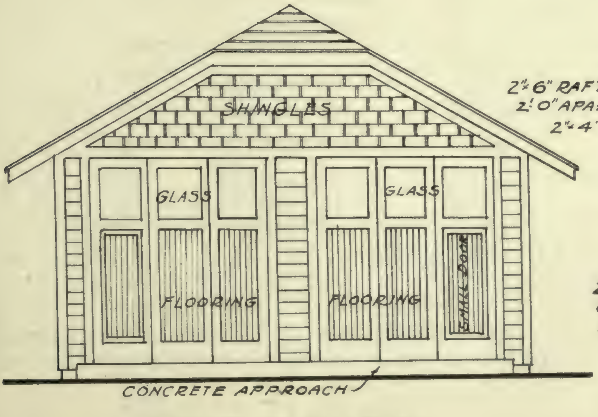


SECTION OF PIT

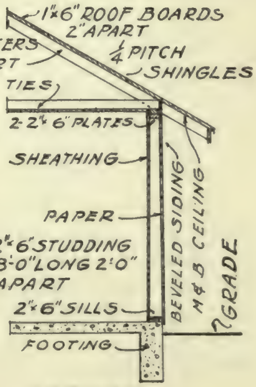




FLOOR PLAN



FRONT ELEVATION



SECTION

A Better Two-Car Garage.

Jones Builds a Garage.

I have a very good friend whom we will call Jones, because that is not his name. He is the only man with whom I have come in direct contact who makes the housing of his car pay him a cash dividend. We had often talked of his buying a car but he seemed to think that he had no use for one and said he had not the mechanical ability which he deemed necessary to operate a car. However, a wide-awake automobile salesman, a good wife and a young hopeful were too much for him and he placed an order for a car to be delivered within thirty days. The following day we talked over the advisability of his building a garage. The car he purchased was one that had at least helped to make Detroit famous and was long on reputation but short on wheel-base, and he had about made up his mind to build a garage just large enough for this type of car.

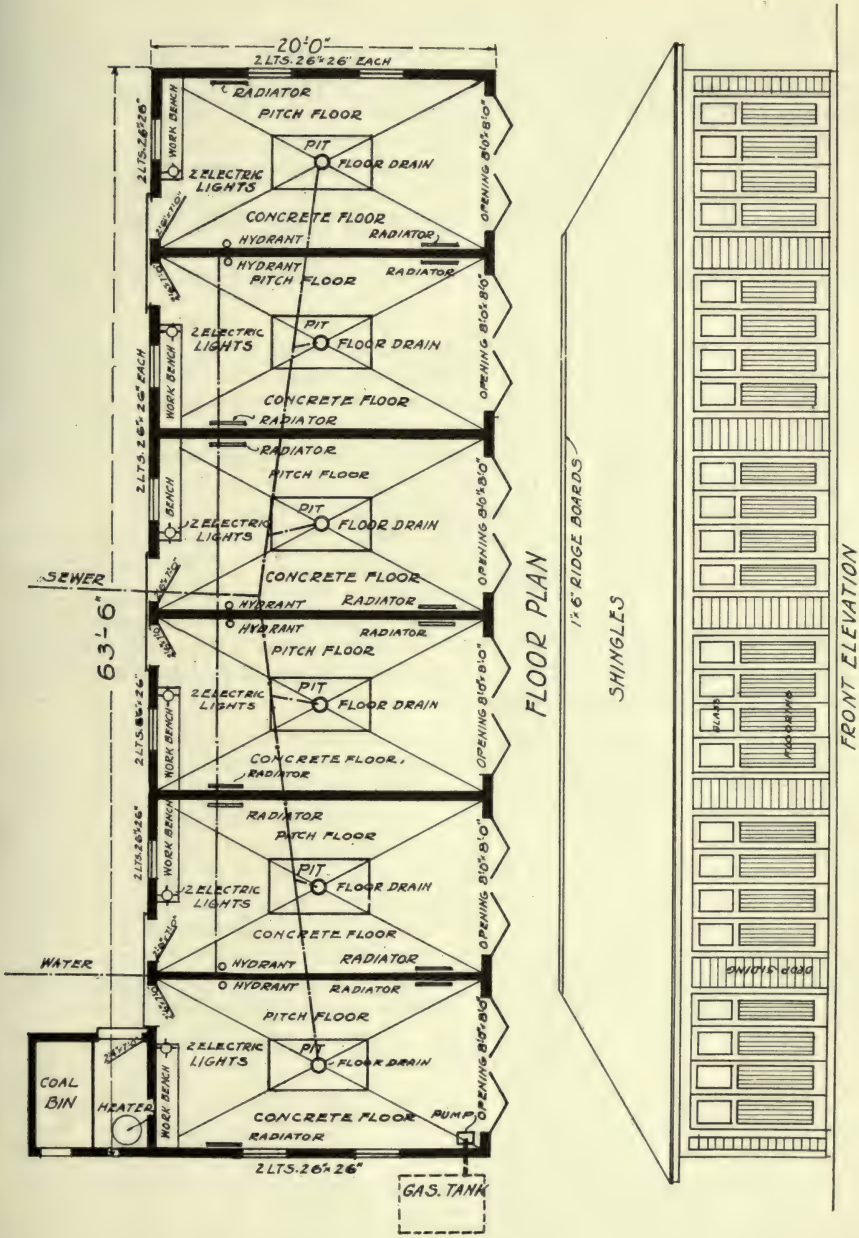
I argued against this, giving as my reason the fact that almost every man who started out with a small car drifted gradually to the larger car type, and I suggested that he build a two-car garage and rent one stall. Jones owned a deep lot, 200 feet, I think, with a width of 75 feet. He argued that if a two-car garage were profitable a six-car garage ought to be considerably more so. We immediately got busy with the contractor and lumberman and between us the six-car garage was ready for occupancy, complete in every detail, within 27 days.

The garage is of frame construction with hip roof, shingled. The building itself is 63 feet 6 inches in length and 20 feet wide and is set four feet from the alley line to allow plenty of turning room. The floor is of concrete with plank cover over the pit. The drain for sewer connection is located in the center of the pit. Each stall is 10x19 feet in the clear and is equipped with water and sewer connection, hot water heat, pit, work-bench, electric lights, in fact, everything that is essential to a first-class garage. Attached to his own garage is a small room where he has a small heater installed, and underground outside is a 200-gallon gasoline tank with pump equipment inside. The building, exclusive of his gas tank and pump, cost Jones in the neighborhood of $1,050. His son looks after this end of the business and provides the five tenants with gasoline at two cents a gallon over the wholesale rate.

Jones' investment, everything included and allowing $100 as value of the land the building stands on, is approximately $1,400. His investment account reads like this:

Initial investment $1,400.		
Five tenants, $90 per year each		$450.00
Depreciation on building 2%	$28.00	
Four tons coal, $8 per ton	32.00	
Water tax	12.00	
Taxes	6.00	
Electric light	12.00	90.00
Total Expense	$90.00	$360.00

A little arithmetic will readily show you that he is cleaning up at least 25% on his investment besides getting his own garage rent free. Of course, everyone is not the possessor of a 75-foot lot, but the average lot in cities of smaller size is at least 50 feet, and remember that garages are in big demand and are big interest payers if your location is good.



The Garage Jones Built.

A Word to the Wise.

If you were about to put money into a bank, even a small amount, you would want to be sure that the bank was a well-managed, conservatively operated one. If the bank building itself was a strong-looking, imposing structure it would impress you with the financial worth of the institution. Now, in garaging a car, remember that instead of the bank, the garage holds your investment of, for instance, a thousand dollars. This amount is a great deal more than the balance carried in the bank by the average car owner. Is it not a sane plan to provide adequate housing for an investment of this amount? Every dollar that you put into a garage is investment. Your property gets the benefit of it every time, and in a quick or forced sale a garage-equipped property is usually a ready seller.

One nowadays sees many alluring advertisements in the magazines about all metal garages, portable garages and what not. In the majority of instances the statements made in these advertisements are correct as far as they go. For instance, I have before me a well written, attractive advertisement, which informs in big bold type, "This Beautiful Metal Garage Complete—$69.75." Then under this caption follows the description in very small type. Of course this price does not include the floor, of either plank or cement, nor does it include the two men's time for two days to erect, nor does it include a good many other things that have to be bought and paid for before the garage is tenable, neither is it large enough for an average sized car. **I have figured out the total cost of this advertised garage and really tried to be very conservative and find that this $69.75 garage—plus freight to your destination, if you please—would cost at least $135 when completed.**

Then look what you would have on your lot. An unsightly building in the first place, entirely out of harmony with everything else in the neighborhood. An intensely warm building in the hot summer sun; an intensely cold building when winter's heavy hand falls upon it. Why, your contractor and lumberman can put up a garage for you that will adorn your lot and at the same time give you a good serviceable building —one you may well be proud of—for many dollars less than the mail-order-house-all-metal-price. Further, you will have put money into circulation in your home town instead of sending it to another town where it is possibly not needed half as badly as at home. Even were the cost the same it pays to patronize your own townsmen, but why—oh why—send away for an inferior article when you can buy cheaper and better at home?

Did you ever stop to consider that your contractor can build as good a permanent or portable garage as you can buy from a mail order house? It will be a better building, too. Why? Because you can see the lumber you are going to have in your building before you pay for it. Your lumber dealer is figuring on selling you further building material. Doesn't it seem reasonable that he is at least going to try and hold your business and your faith in him by selling you good material at only the fair margin of profit to which he is justly entitled?

Implement Sheds

by

K. J. T. Ekblaw

Price, Ten Cents

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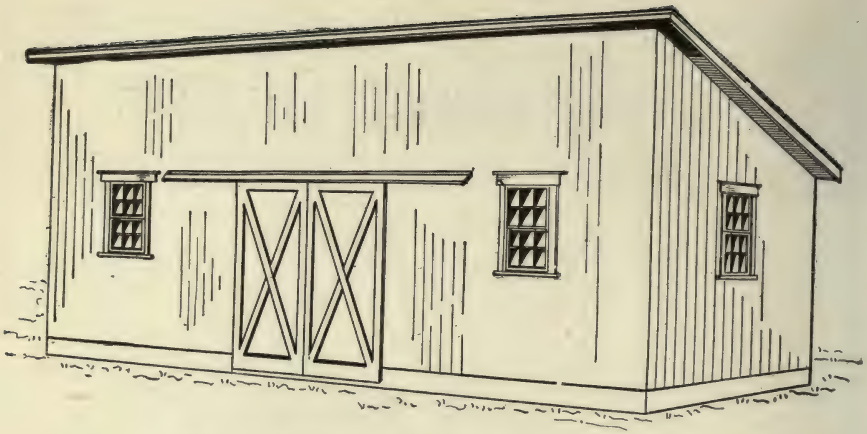


Fig. 1. Exterior of Simple Implement Shed

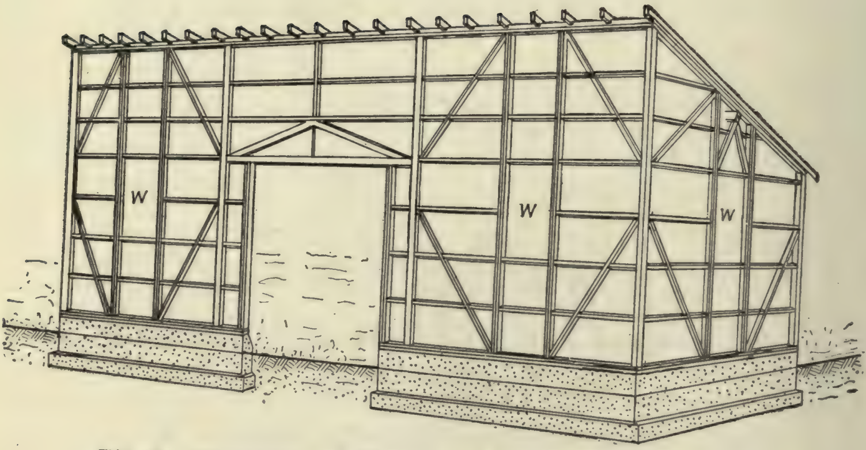


Fig. 2. Perspective of Framing of Simple Implement Shed

Implement Sheds

By K. J. T. Ekblaw

A very fair indication of the thrift and general prosperity of a farmer is the method he employs in caring for his tools. Shiftlessness, waste, lack of energy, constant buying and heavy burdens of debt will accompany poor care. Good care is an indication of shrewdness, business ability, long-lived machinery, comfortable bank balances and the assurance of a peaceful, prosperous future.

To the progressive man, figures speak more forcibly than does the most persuasive lecturer on economic topics. The report of the United States Census for 1910 contains some figures that bear a distinct message to the farmers of the country. In 1900 the value of all farm property in the shape of farm implements and machinery was $749,775,970; in 1910 this same value had increased to $1,265,149,783, representing an increase of 68.7 per cent. This increase can be ascribed mainly to increased quantity rather than to higher prices, for the increase in price of farm machinery has been comparatively slight. It means that the farmers are realizing the benefits to be derived from the use of labor-saving machinery. In 1900 the acreage of improved land in farms was 414,498,487; in 1910 this became 478,451,750, an increase of only 15.4 per cent. These figures may be a little more significant if expressed in the following way: In 1900 there was $1.80 worth of machinery for each acre of improved farm land; in 1910 this had increased to $2.65, or an increase of over 47 per cent.

These figures will immediately indicate an opportunity for the furtherance of economic agriculture. With so much capital invested in equipment, the American farmer would certainly be a very bad business man indeed if he did not take some means of protecting this equipment to reduce depreciation and to increase its length of life. The question has sometimes been asked, does it pay to house farm machinery? Is it not a better practice not to give any special care to the machinery but use it as long as it will run without care then buy newer and more up-to-date equipment?

The situation bears some consideration. According to Census figures, the average investment per farm in farm machinery is almost exactly $200. This, however, is the case when every sort of farm is included, and since the Census Bureau's definition of a farm is extremely liberal it would not be practical for our purposes. A fair estimate of the average value of farm machinery on a farm is $1,000. No reliable figures are available to indicate the rate of depreciation of farm machinery; one farmer will take excellent care of his binder and it may do service for twenty or twenty-five years, while another farmer will leave his binder in the middle of the field where the last stalk of grain was cut, and it would be surprising if his machine could operate satisfactorily for more than five seasons. To take ten years as the average life of farm machinery is certainly to be considered conservative.

Most farm machines are well and substantially constructed and will render satisfactory and efficient service with slight repairs for a much longer term of years than the average which has just been given. It is entirely safe to assume that the average length of efficient service can be increased to fifteen years providing proper care is given. It is almost equally safe to assume that the average life of uncared-for machinery will not be much more than five years.

The farmer who has a thousand dollars worth of machinery to which he gives no care and attention will then have an annual reduction in value of $200, besides his interest charge of $60 on his investment or a total debit of $260. The farmer who properly houses his machinery will have an annual deduction of $66.66 for depreciation and the same interest charge of $60. He will have, in addition, an annual charge of $25 for interest and depreciation on his building if it cost $250, or a total of $151.66, which is $108.34 less than that of his improvident neighbor. The careful farmer then may consider that he has in his implement house an investment representing over $1,800 as shown by the saving it brings him; as a simple implement shed can be built for $250,

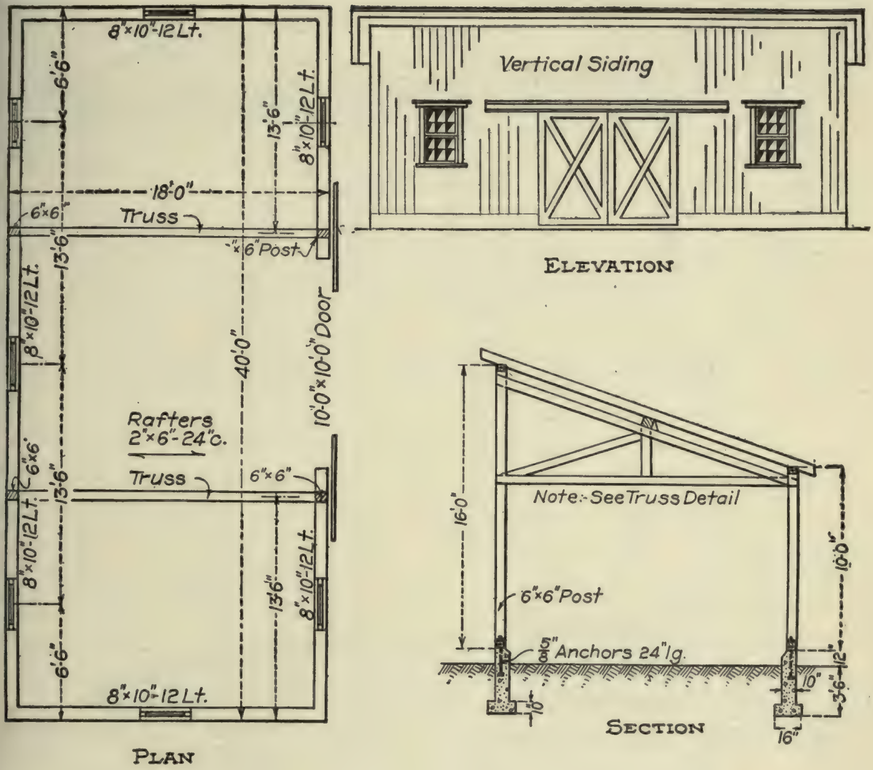


Fig. 3. Details of Simple Implement Shed

Only one wide sliding door is shown, though another smaller door can be inserted if desired. The truss construction shown in Fig. 10 is used above the wide door. Either vertical or horizontal siding may be used, the former being simple and satisfactory construction. The front wall may be omitted in localities where inclement weather is uncommon.

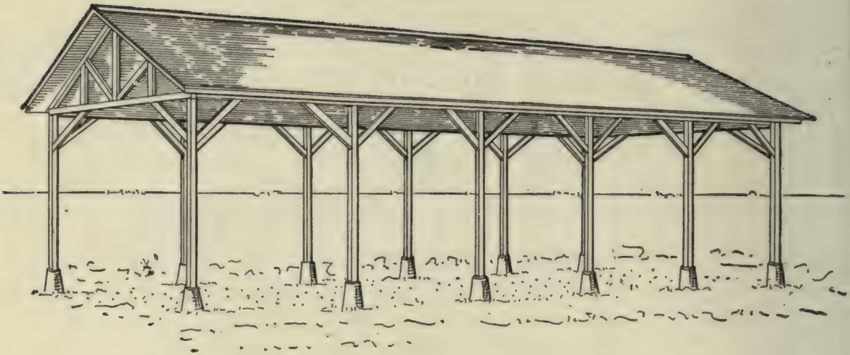


Fig. 4. Exterior of Open Type of Implement Shed

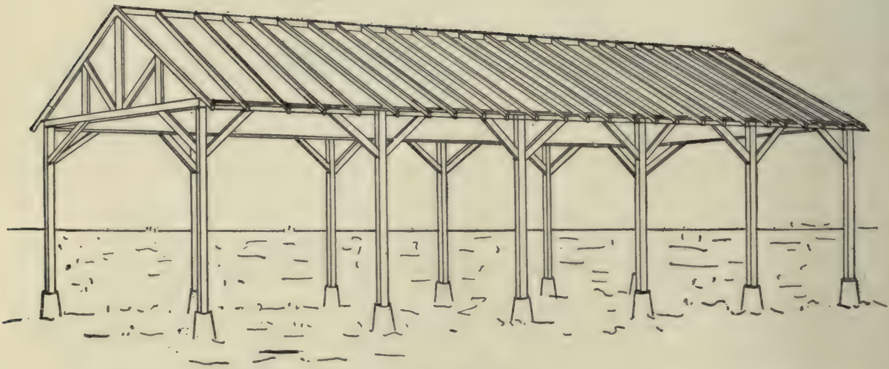


Fig. 5. Perspective of Framing of Open Type of Implement Shed

a net profit of an interest-paying $1,550 remains. Putting the problem in another way, on many farms the savings on machinery will pay for a shed in two or three years.

In view of the fact that the small tractor is becoming an extremely popular source of farm power, special consideration should be given to its shelter. The tractor is an implement that would be extremely likely to be injured as a result of exposure to weather. It is entirely possible that the damage which may be done to this one single machine in one winter's exposure may be sufficient to pay for the cost of a machine shed which will house all the implements on the farm.

So much for the economic side. The figures that have just been given relate only to a very conservative case. On many farms the saving would be a great deal more. Besides this there are other things of which the value cannot be estimated, such as the benefit of having a machine that will operate when it is called upon to do so; the added value an implement shed gives to the farm; and the additional prestige which will redound to the owner of the farm.

The careful farmer will, of course, find that criticisms of ill-cared-for machinery do not apply to him; he has a machine shed, and knows the value of paint, oil, and grease in extending the life of implements. His equipment always looks new, for as rust breaks through the protecting coat of paint, a new coat is immediately applied; and his plowshares, discs, cultivator shovels, and other bright parts of implements are always given a thorough coating of grease before being put away for the winter. As a result, his implements are ready for business when spring comes and time is valuable.

THE DESIGN OF THE BUILDING

In preparing the design for machine sheds one of the first considerations is that of economy. A machine shed is a building which is almost always used for no other purpose than to shelter machinery. It is not like a bin for the storage of grain where strength is an exceedingly important factor nor is it like a barn where so many operations are carried on within; consequently the simplest and cheapest structure that is consistent with reasonable durability is the one that is the most advisable. Wood is a product available in every section and is the cheapest and most suitable material for the construction of an implement shed.

Paint, the great preservative, should be applied to all

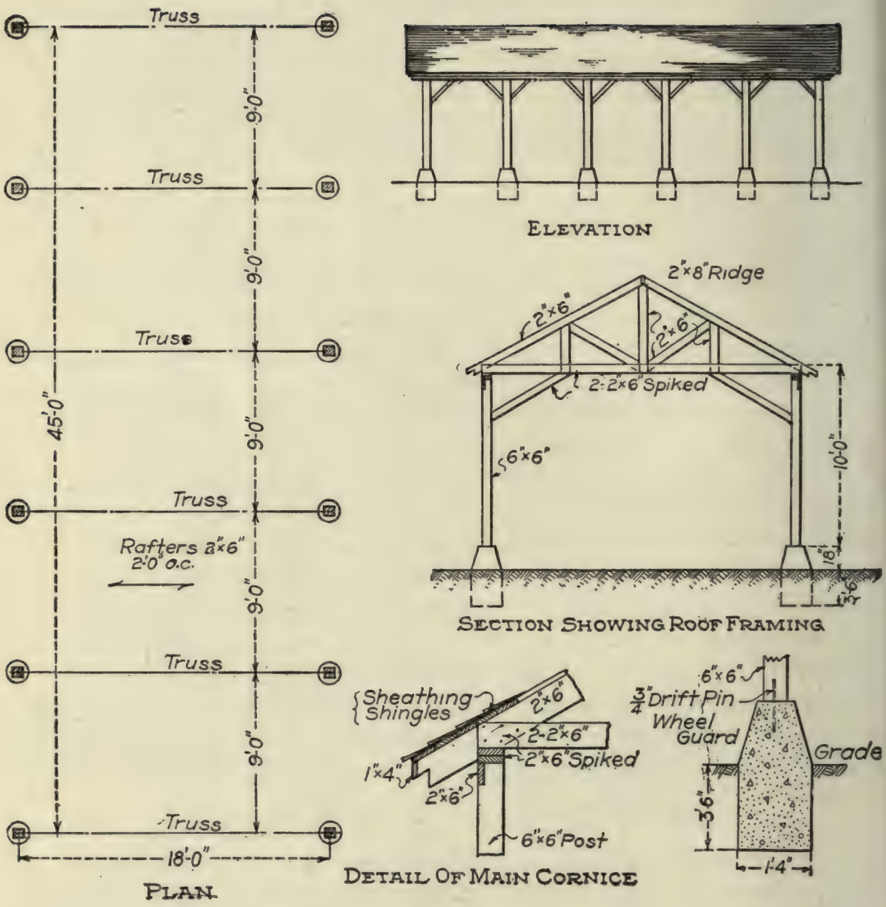


Fig. 6. Details of Open Type of Implement Shed

Framing of 6x6 posts, thoroughly braced. Ends may be boarded or left open as desired. Foundation piers act as wheel guards. Width between posts can be varied to suit requirements.

farm buildings. The initial cost of two coats of good paint is not prohibitive; the durability of the wood may be increased almost indefinitely if the surface is kept covered to prevent the ingress of the spores of decay. The prosperous farmer's buildings are always kept painted, not only to preserve the wood, but to improve the appearance of the buildings themselves.

On new wood, two coats are usually sufficient. The first coat should contain mainly oil, with a small amount of the base and coloring pigments, so that it will permeate every pore; the second coat should be heavier, containing less oil and more pigment. Surfaces that have been painted can be kept in good condition by the occasional application of a single coat.

The planning of an implement shed will require data as to the number and size of machines and the amount of space that each will occupy. The arrangement of the machines so as to make them easily accessible at times when they are most needed is also important, e. g., a binder being used but once a year may well occupy a far corner, leaving a space near the door for the mower and plow, implements which are used oftener and for longer periods than the binder. The manure spreader, wagons and buggies are used so much throughout the year that they should be especially accessible. Table I, pages 19 and 20, gives the floor space required for most farm machines; the height of the machine is also given. Of course, it is entirely possible to crowd machines together as they are put into the shed, and so much saving in room can be accomplished in this way that little clearance space need be left. For instance, the outer edge of a binder platform can be easily raised several feet, provided a pair of reel slats with the attached arms are removed, and in this space beneath the platform can be stored such implements as hand drill, walking plows, etc. Similar opportunities for economy in space can very easily be found.

In general the construction of a machine shed is that of the very simplest; yet utility and beauty can be very easily combined with simplicity. Since the building is not subjected to any heavy load, as would be the case with a crib or a barn, the framing is just sufficiently strong to safely hold the wall and roof covering and to prevent collapse of the building from wind or snow and ice loads. Very often 2x4's or 4x4's constitute the studs or posts and no heavier stock is used throughout the building. In wide sheds it may be found

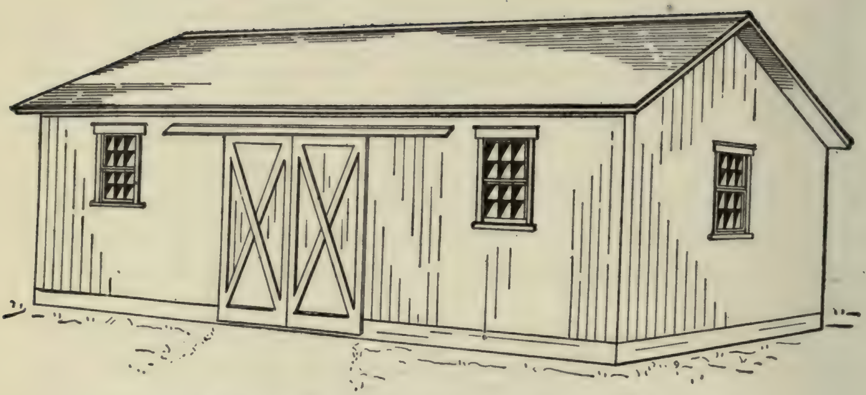


Fig. 7. Exterior of Wide Enclosed Implement Shed

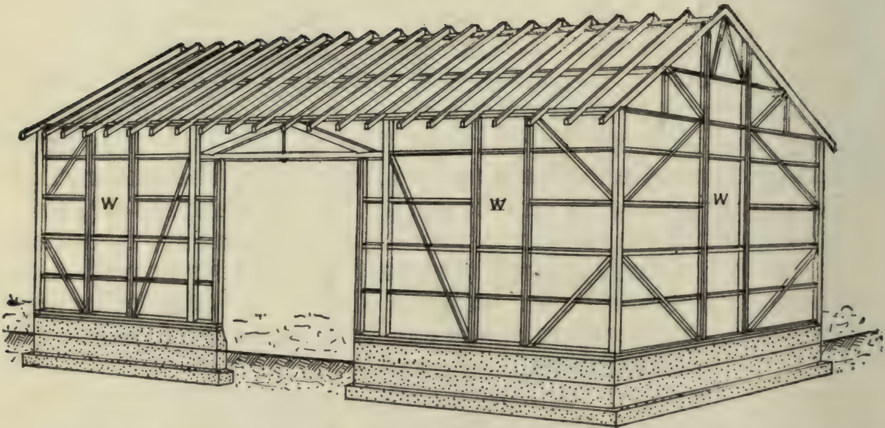


Fig. 8. Perspective of Framing of Wide Enclosed Implement Shed

necessary to use larger stuff and especially in the plate above the wide doorway. A two-story machine shed will, of course, require heavier and more substantial framing, but a two-story shed is comparatively rare. A floor may or may not be used as the owner may desire. It is likely to prove somewhat expensive in first cost and in maintenance, though for convenience it is much to be desired, especially if any repair work is to be done in the building.

The roof may be of almost any style from the simple single pitch shed roof to the modified shed roof or the ordinary double pitch gable roof. It is desirable that the pitch should be not less than one-quarter in order to get the greatest life out of the shingles, which are likely to collect moisture and give shorter service where the pitch is quite flat. The foundation of a machine shed will naturally not be designed for great strength except in the case of a two-story structure, since the only load which it has to support is that of the superstructure itself. A footing 12 to 16 inches wide at the bottom and extending down a foot or 15 inches into solid soil will support a building of this kind. However, if a concrete floor is put in the building as is sometimes done in the more expensive ones, it will be well to extend the foundation wall and footing to a point below the frost line, which will vary from a foot to three feet according to climate.

Sills are usually not necessary in the simple framing of machine sheds. The posts can be set directly upon foundation walls and fastened in any one of many different ways that have been devised. Timbers are more subject to decay at the ends than elsewhere, consequently it is advisable to treat them at this point with a preservative such as creosote. This will add greatly to the durability. The foundation wall should be brought up some distance above the ground so as to further protect the bottom timbers from moisture. This above-ground extension must be omitted at doorways.

One of the most serious problems in the design of a machine shed is the insertion of doors. Wide doors are an absolute necessity, especially for certain machines. An eight-foot door is large enough for the majority of farm machines, even allowing the modern binder with its folding grain dividers to enter in safety. The wide drill, the rake, and several other implements require a much wider door than this and it may be necessary to provide an opening 12 or even 14 feet wide. This leaves a long unsupported section

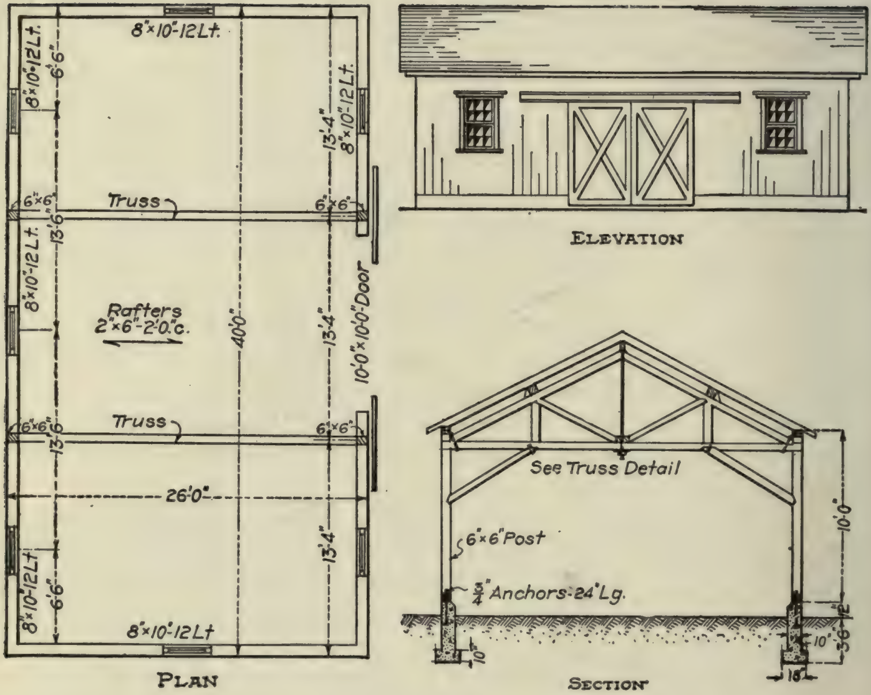


Fig. 9. Details of a Wide Enclosed Implement Shed

Strong framing is necessary to insure durability in this structure. Members may be solid or built up. Details of one form of roof truss are shown in Fig. 11. Note solid foundation. Doors may be located to suit requirements.

of the plate directly above the doorway. To keep it and the roof from sagging, special provision must be made either by putting in an exceptionally strong plate at this point, by building up a small wooden truss, or by making a truss of wood and iron as shown in the illustration. (Fig. 10.)

The doors themselves should be very solidly and substantially made. It is a matter of good practice to have as few doors as possible. In the average machine shed one 8-foot door and one 12 or 14-foot door are sufficient to meet requirements. A door wider than four feet should not be swung on hinges under any circumstances, as it is sure to pull out the hinges or to sag very badly. Sliding doors of good construction are to be recommended in preference to hinged doors (Fig. 12). It is entirely possible to make a good close-fitting door of this type and there need never be any trouble in its operation.

The use of other buildings for the storage of farm implements is not a desirable procedure except in certain instances, such as keeping wagons in the driveway of cribs, leaving the spreader at the end of an alleyway of a barn for convenience in loading, etc. In general, other buildings are much more expensive than a machine shed and those portions of them devoted to the storage of farm implements could in most cases be more profitably used, especially when the very small unit floor-space cost of a machine shed is taken into consideration. Then, too, if a special place is not provided for the implements, the farm animals may come in contact with them, causing injury of the animals or damage to the machines.

REPRESENTATIVE TYPES OF SHEDS

The Simple Shed Type. The needs of the average farm for a cheap, easily built implement shed are met by this building. Illustrations of this type of shed are shown in Figs. 1, 2 and 3. The framing consists of 6x6 posts set on a light 1:2½:5 mixture concrete foundation at intervals of eight feet, the plate consisting of two 2x6's. Short diagonal braces can be set in underneath between the plate and the post in order to give the plate further support. The rafters for a span of 18 feet should be at least 2x6 and better 2x8, set not less than two feet apart on centers. The wall covering may consist of vertical siding, either 10 or 12-inch boards, with the cracks covered by ogee battens. For horizontal siding,

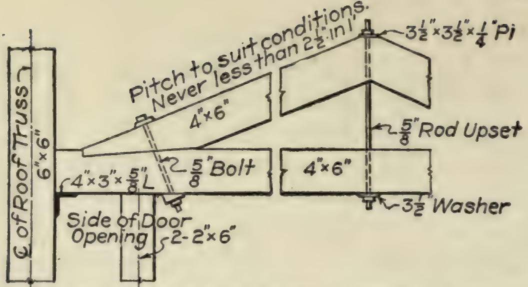


Fig. 10. Detail of Truss Over Large Doors in Implement Shed

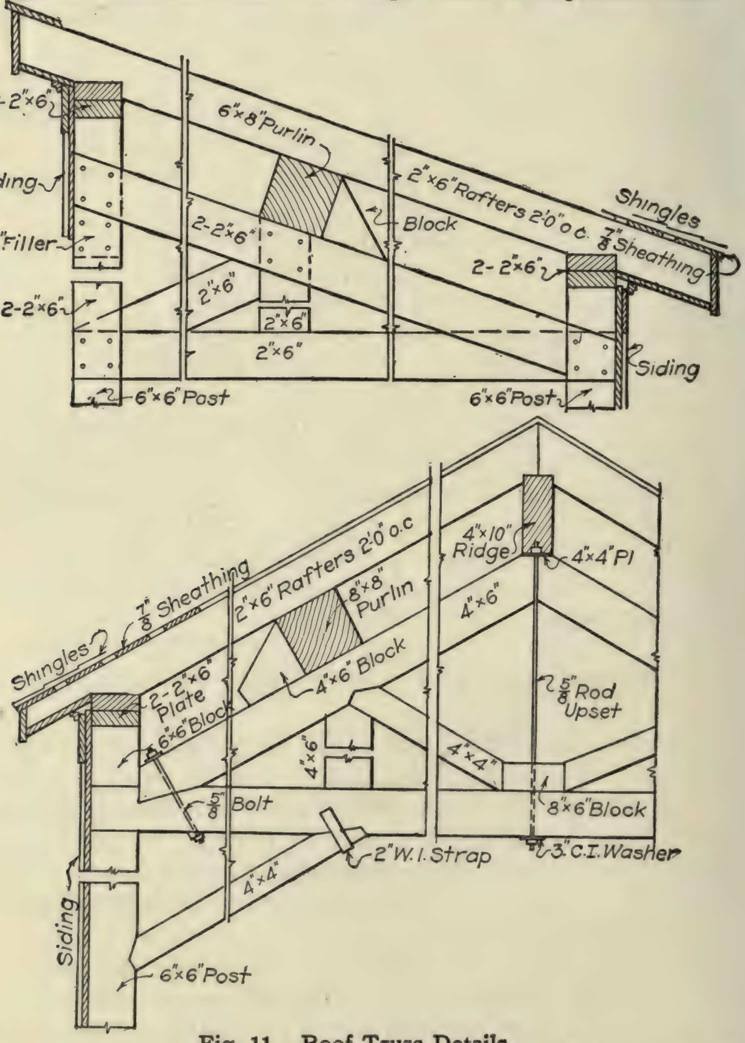


Fig. 11. Roof Truss Details

The upper illustration (Fig. 10) shows a method of building a truss above wide doors to prevent sagging of roof. It may be varied to suit circumstances.

The roof trusses shown in Fig. 11 suggest methods of framing for wide sheds, as in Fig. 3 and Fig. 9.

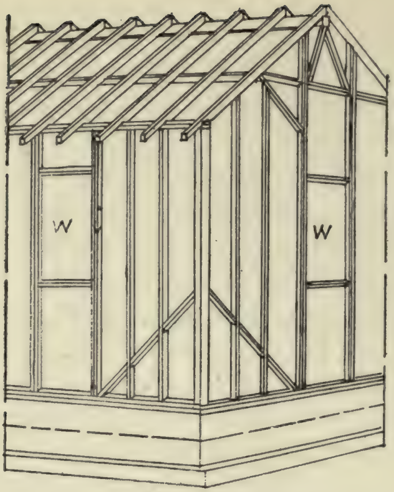
studs are necessary; these should be 2x4's, placed not over 3 feet apart. Either drop-siding, German or novelty siding or ordinary weather-boarding may be used satisfactorily, but the latter is somewhat light for a building of this kind and would probably not be as durable as the others mentioned.

The building may be entirely enclosed, having the doors on the high side. The practice of enclosing the building entirely is generally to be recommended, though sometimes for the sake of economy and convenience and in localities where the winds are very constant in their direction, it may be advisable to omit part of the exterior wall covering, leaving one side open, this side being the one opposite to the direction from which the prevailing winds come.

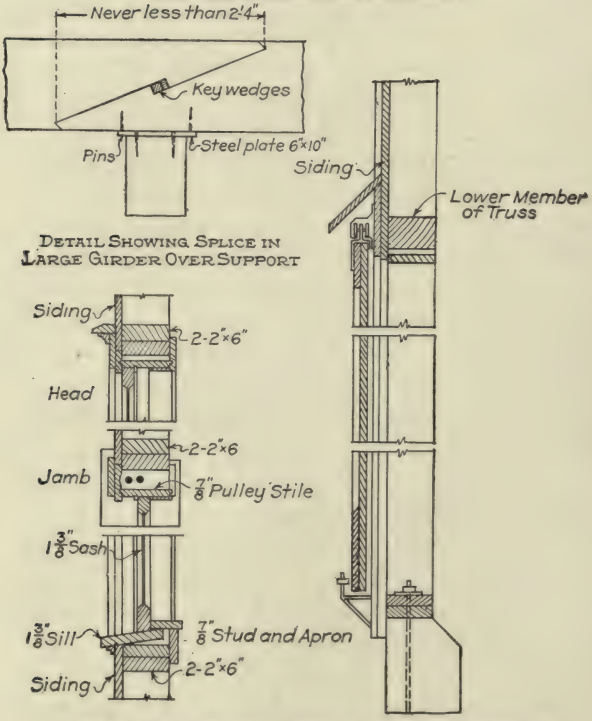
The Open Shed Type. Under some circumstances the open shed type of building (shown in Figs. 4, 5 and 6) will be the more suitable. This is especially true where wagons, racks and spreaders are used frequently. The framing of the building consists simply of 6x6 posts set on concrete piers at intervals of 9 feet. On these are set 2x6 rafters supporting a double pitched gable roof. The building is opened on both sides but both ends may be enclosed.

This building is extremely convenient, although it does not give very thorough protection to the machines. A wagon or spreader can be driven directly through one of the bays and horses unhitched outside. With a building 18 feet wide and eaves overhanging one foot, the implements will be protected from all but driving rains, though sweeping snow will have free access to the interior. The posts are placed nine feet apart in order to provide sufficient room for driving a team through. It may be possible to reduce this dimension to eight feet, or to increase it to 10 feet in case a three-horse team is to be driven through. The concrete piers supporting the posts are made conical in shape, acting thus as wheel guards to prevent the hubs of the wheels from striking the posts.

One or more bays of the shed may be enclosed if desired to give adequate shelter to machines, such as mowers, binders, etc., which would suffer from exposure. Of course, the shed as well as the preceding one can be built to any length desired, though a building more than four times as long as it is wide will present a somewhat peculiar appearance on account of the long, low roof line.



METHOD OF CONSTRUCTION
FOR HORIZONTAL SIDING



DETAIL SHOWING SPLICE IN
LARGE GIRDER OVER SUPPORT

DETAIL SECTION OF WINDOW FRAME

DETAIL SHOWING METHOD OF HANGING LARGE BARN DOORS

Fig. 12. Construction Details

These details apply in general to the implement shed plans. The girder splice shown makes a firm, solid joint. If double hung sash are used, standard window framing is employed, as shown. Wide doors are always hung on a track; the detail shows weather strip at top, and bracket with roller at bottom to keep door from swinging out.

The Wide Enclosed Type. A better and a little more expensive type of implement shed, yet one perhaps better suited to the average farm is shown in Figs. 7, 8 and 9. This shed is made 26 feet in width and as long as may be necessary, although a building 26x40 will usually be found sufficiently large to house the machines on the average general-purpose farm. The framing of this shed is a little more substantial than in the types previously discussed, consisting of 6x6's with 4x6 plates. Should horizontal siding be used, it will naturally follow that instead of using these posts, 2x4 studs will be employed as previously described in the simple shed type on page thirteen. The height of the walls should be not less than 10 feet, which with the gable roof will make the building a little more attractive in appearance than the one previously described. A span of 26 feet is almost too great for the adequate support of the roof unless some device such as truss bracing and purline is used to give the rafters additional stiffness. (Fig. 11.)

Experience has shown that the two widths—18 feet and 26 feet are peculiarly adaptable to the dimensions of the various farm machines. Using the 26-foot width, considerable opportunity is given for the utilization of the floor space, since a wider floor area unsupported by posts is available. As far as possible, interior posts should be avoided, for they interfere very seriously in the placing and moving of machinery.

The Two-Story Type. As stated before, the use of a two-story machine shed is rather rare, for two reasons: First, the additional expense in material and labor, and, Second, the difficulty of getting machines up to the second floor. The only advantage that is gained is the doubling of the floor space under the same roof.

The construction of the building (illustrated in Figs. 13, 14 and 15) will necessarily be rather substantial. The framing may consist of 6x6 posts and 4x6 girts, which should be securely joined in order to give rigidity to the structure. The girts are located at vertical intervals of not to exceed 5 feet, so as to afford good nailing for vertical siding. If horizontal siding is used, the girts may be spaced wider, say, one each at the top, bottom, and middle of the post, while 2x6 studs are set in on which to nail the boards. Diagonal bracing is a decided advantage. The building may be constructed either 18 or 26 feet wide, and it is seldom that a

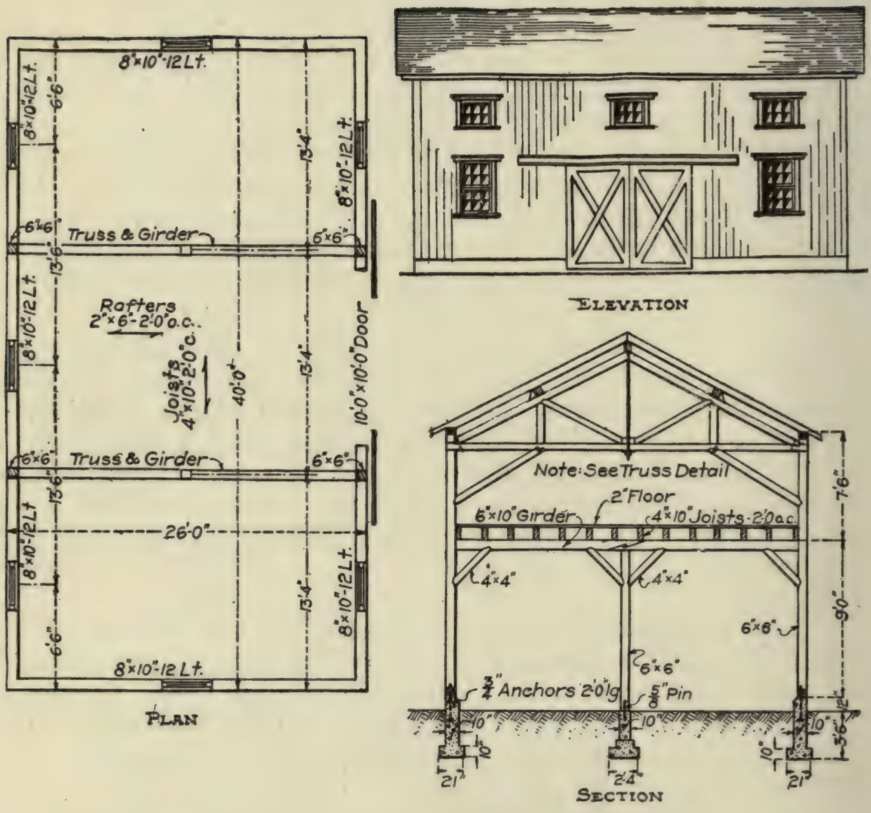


Fig. 13. Details of Two-Story Implement Shed

The framing in this type of shed must be unusually strong and substantial. The girders and, in fact, all framing members, may be either solid or built up. A central post is necessary in each framing unit.

building longer than 40 feet will be necessary. The foundation should be much more substantial than in the types previously described. It should extend well below the frost line and be almost as strong as that used for barns.

The second floor will be used for the storage of the lighter machines such as small plows, harrows, drills and all the lighter tools which make up the farmer's equipment; while the first floor will be utilized for the storage of the heavier machines such as binders, wagons, etc. Getting the lighter machines up to the second floor may be accomplished in one of two ways. An ordinary block and tackle can be utilized either through an outside door in the gable of the roof or through a hole in the floor in the interior of the building. If space is available the construction of a rather steep runway outside the building and leading to the second floor may be advantageous. This runway can be constructed of rather light material, using a pair of 4x6's for joists, and flooring them with rough 2-inch stuff. An angle of 30 degrees with the horizontal will make it possible to pull machines up the runway with only a small amount of labor. This arrangement has been found to be superior to the use of a hoist. It can be used to the best advantage when the shed is located on the slope of a rather steep hill.

TABLE I.

Floor Space and Height of Space Required to House Common Farm Implements.

Implements—	Floor Space in Feet	Height of Space in Feet
Plows—		
Walking	8x3	3
Sulky and horse gang (tongue off; add 10 ft. for tongue)	8x6	4
Engine gang	16x7	5
Harrows—		
Spike tooth, per section	5x5	2
Spring tooth, per section	5x4	1½
Single disc, 8 ft. with truck (tongue off)	6x9	4
Double disc, 7 ft. with truck (tongue off)	8x8	4
Weeder—		
(Thills on)	13x8	4
Grain Drills—		
12x7 (tongue off; add 10 ft. for tongue)	5x8	5
16x7 with press attachment (tongue off)	7x11	5

Floor Space and Height of Space Required to House Common Farm Implements—Continued

Implements—	Floor Space in Feet	Height of Space in Feet
Rollers—		
Smooth	3x10	4½
Corrugated, single (tongue off; add 10 ft. for tongue)	3x10	4
Corrugated, double	4x8	4
Corn Planter—		
Two row (tongue off; add 10 ft. for tongue)	5½x6	3½
Cultivators—		
Walking, one horse	7x2	3½
Riding, single row (tongue off; add 10 ft. for tongue)	8x5	4
Riding, two row (tongue off; add 10 feet for tongue)	8x10	4
Alfalfa (tongue off; add 10 ft. for tongue)	7x6	5
Mower—		
6 ft. (tongue off; add 10 ft. for tongue)	5x6	7
Binders—		
Grain, 8 ft. (tongue truck off)	8x14	7
Grain, 6 ft. (tongue truck off)	8x12	7
Corn (tongue off; add 11 ft. for tongue)	13x6	7
Hay Rakes—		
Self-dump (thills off)	5½x11½	5
Side-delivery (tongue off; add 10 ft. for tongue)	13x9	5
Tedders—		
Kicker (tongue off; add 8 ft. for tongue)	5½x8	5
Combination (see side-delivery rakes)		
Hay Loader	14x9½	9
Ensilage Cutter, 20-ton (tongue off)	11x5½	7
Corn Shredder, 8 roll	20x8	9
Corn Sheller	20x8	11
Hay Press	16x6	6
Grain Separator, 32-inch	26x8	8½
Clover Huller	24x8	8
Gasoline Tractor, 20-4 H. P.	15x9	9
Gasoline Tractor, 10-20 H. P.	12x8	8
Portable Engine, 6 H. P.	9x5	6
Fanning Mill, 24-inch	4x3½	5
Wagons—		
Farm gear (tongue off; add 10 ft. for tongue)	11x5½	4
Wagon with box and top (tongue off)	11x5½	5½
Wagon with box and tip top (tongue off)	11x5½	6½
Wagon with hay rack (tongue off)	16x7½	5
Buggies—		
One seated (thills up)	8x5½	7
Two seated (tongue off)	10x5½	8
Grain Dump (knocked down)	12x4	4
Potato Machinery—		
Planter (tongue off; add 9 ft. for tongue)	5x3	4
Sprayer, two wheeled barrel (thills off)	6x6	5
Digger, wheeled, elevator (tongue off)	13x4	3
Automobiles—		
Small	11x6	7
Large	14x7	8
Phosphorus Distributor, 1,000 lbs. (tongue off; add 10 ft. for tongue)	4x10	4
Manure Spreader, 50 bu. (tongue off; add 10 ft. for tongue)	17x7	6

There is a WOOD
For Every Need

THIS?

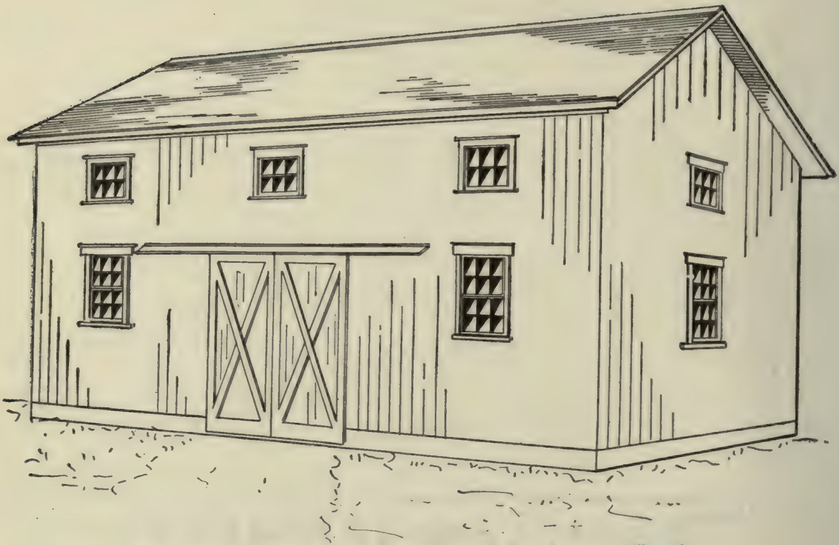


Fig. 14. Exterior of Two-Story Implement Shed

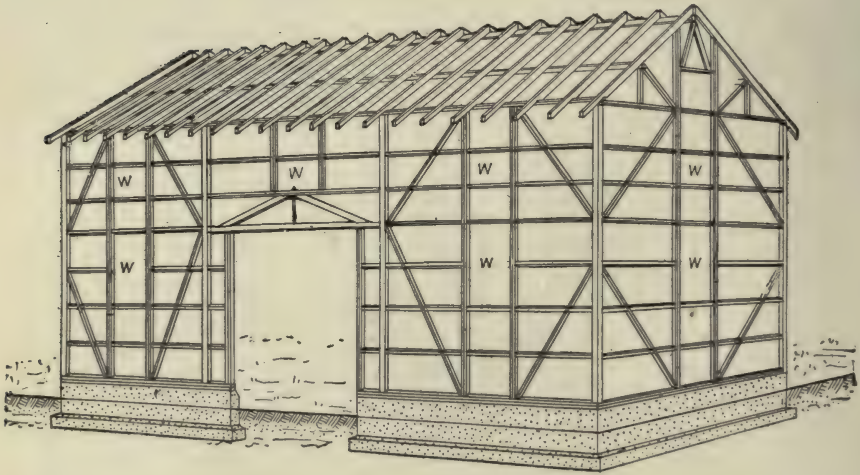
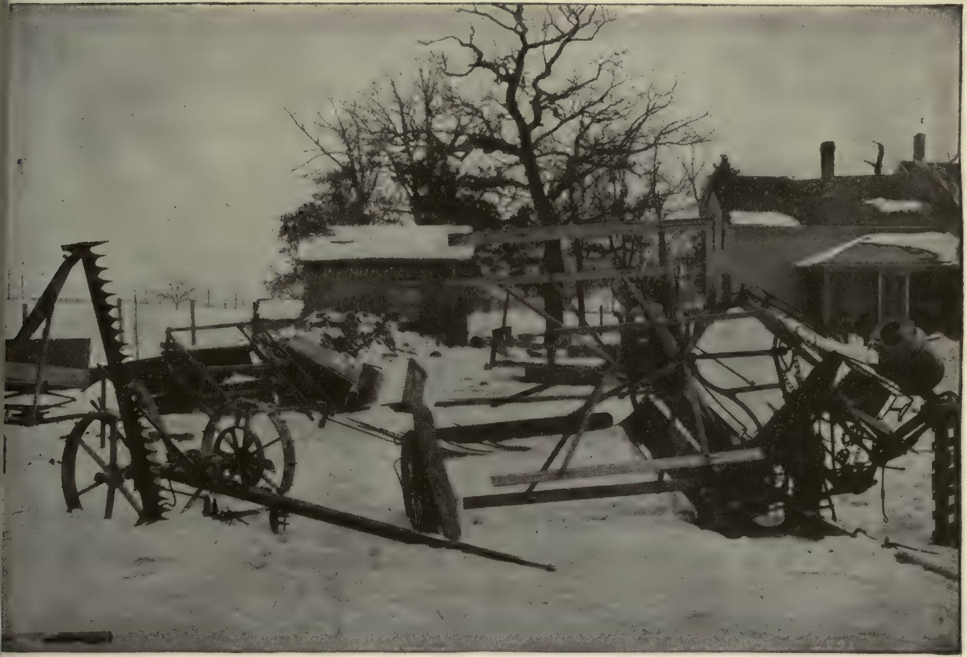


Fig. 15. Perspective of Framing of Two-Story Implement Shed

OR THIS?

The Automobile and Family Carriage Are Kept Under Cover. Is This Fair to the Implements Which Make the Farm Pay?



Courtesy Tractor Farming. Fig. 16

"When it comes to actual waste, the Great American Desert with its constant canopy of blue sky over it has very little on the Great American Machine Shed. The chief difference is that the former is found in a particular locality only, while the latter extends from coast to coast. Both are in the open, both represent zero in profitable and economical usage, and both need the undivided attention of conservation experts."—Tractor Farming.

Wood "Where Best"

The legitimate use of lumber where it is best, or by proper selection or treatment can be made to serve economically and safely, is the aim of the lumbermen in publishing a series of bulletins on Farm Structures. Wood has for so long been the most widely used building material that its availability and importance have either been taken for granted or lost sight of. It is helpful to review the outstanding features of the present situation:

Wood remains the most universal, most adaptable building material in the world.

The supply is ample for all requirements, and the kinds and grades best suited for all purposes are obtainable everywhere.

In cost it remains one of the cheapest materials.

It is the lightest building material known, and the strongest, weight for weight.

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There is no material more beautiful in appearance, more susceptible to artistic finish, nor which is as productive of sentiment and satisfaction for home building.

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The relative qualities of durability, serviceability and workability should be considered in selecting wood for homes and farm buildings. **Consult the local lumber dealer.** His knowledge and advice will assure cheaper, more stable buildings.

Except where naturally durable woods are available, a preservative treatment will prove economical for timber exposed to moisture and decay, as sills, basement flooring, fence posts; and in similar situations.

Grain Storage Buildings

by

K. J. T. Ekblaw

Price Ten Cents

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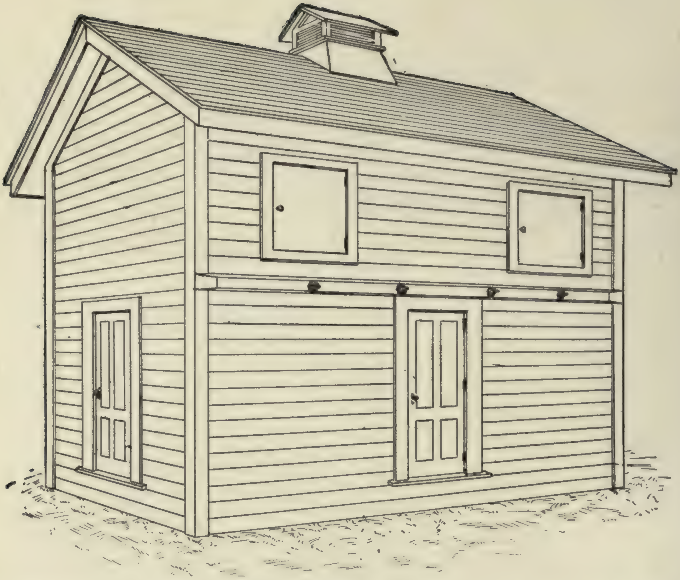

Fig. 1. Exterior of Small Granary with a Capacity of About 1,900 Bushels.

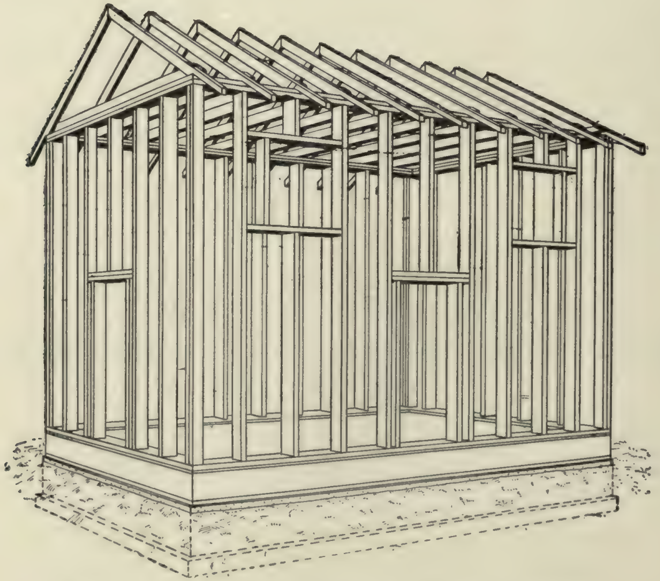

Fig. 2. Perspective of Framing of Small Granary.

Grain Storage Buildings

By K. J. T. Ekblaw

The chief fault of cribs and granaries as they are built in the majority of instances is that they are constructed with too little regard for strength and durability. False economy is practiced when such a building is erected with just a few stones or an occasional pier for a foundation and with light, unsound timbers for sills and framework. Proper consideration is not given to the great strain to which a crib or bin is subjected, due to the lateral pressure from the weight and settling of the grain; this strain is particularly severe at the floor and near the bottom of the walls.

Buildings for the storage of grains are of two kinds, those which are usually styled granaries and which are used for the storage of small grains, and those which are known as cribs and are used almost exclusively for the storage of ear corn. As far as the general design is concerned, principles which apply to one type will apply equally well to the other. The main differences are: first, that granaries must have tight walls and floors while cribs should have walls with air spaces which permit ventilation; second, cribs must be made narrower than granaries in order to make provision for the removal of the rather considerable amount of moisture which is given off by the drying corn.

PRINCIPLES OF CONSTRUCTION.

Pressure on Walls. Considerable attention has been given to the investigation of the pressure due to small grains, but, practically no data are available concerning ear corn. It might be possible to consider ear corn similar to coal in its action. Assuming that this consideration is correct, it is possible to obtain values which could be used in the design of extremely high cribs.

It has been found by a number of experimenters that the ratio of lateral to vertical pressure of grain varies from 0.3 to 0.6. The vertical pressure, or pressure on the bottom of a bin, rarely exceeds 6 pounds per square inch, this value being reached with a depth of about 50 feet, which is much deeper than would be the granary on any ordinary farm. The pressure for a depth of 20 feet, which would be the maximum for the average granary, will not exceed 4 pounds per square inch and at a depth of 10 feet one-half this value is a safe assumption.

Some rather interesting conclusions have been made as a result of the experiments that have been conducted. It was found that the lateral pressure of grain on bin walls increases very little after a depth of 2½ to 3 times the diameter of the bin is reached. Moving grain also indicated a somewhat greater pressure than that of grain at rest, the variation under ordinary conditions never exceeding 10 per cent. The maximum lateral pressures that were measured occurred immediately after filling. Using the results of experiments which have been made to determine the lateral pressure of coal bins, and assuming that the weight of ear corn is 60 per cent of that of coal, we will obtain for a total lateral pressure on a section of crib wall 1 foot long and 20 feet deep approximately 1,500 pounds. In a depth of 10 feet this value is about 400 pounds, showing that with deep cribs, especial attention must be given to the framing in order to make it sufficiently strong to resist the heavy strain. It is doubtful if a crib deeper than 20 feet will be used on the ordinary farm on account of the difficulty of elevating the grain. When higher cribs than these are used, it is advisable to consider them as coming under the head of elevators, and their design should be left to the experienced engineer.

Foundations. Since the foundation of grain storage buildings must support not only the weight of the superstructure of the building, but that of the grain also, it follows that the foundation is an extremely important feature. The best practice at the present time is to make use of concrete for the foundation. A good foundation can be made of a 1:2½:5 mixture of concrete, the foundation wall extending into the ground below the frost line. An adequate footing at least twice as wide as the foundation wall is thick is necessary. The width of the footing should be at least 16 inches, and in certain loose soils should be as much as 20 inches. Very often the concrete is placed only under the sills or sleepers, usually extending in three strips the length of the crib; this leaves the ends open for the admission of rodents, however, and at a comparatively small expenditure of time and labor this could be entirely closed up.

Floors. From some standpoints it would be a desirable thing to use concrete for the floors of cribs and granaries. However, in some localities a decided objection exists to the use of concrete as a flooring material, the objection being based on the belief that it is retentive of moisture and will induce rot in grain. It is entirely possible to construct a concrete floor that will be practically dry by making it of a rich mixture so as to make it dense and impermeable, having first provided for excellent drainage so that there will be no accumulation of moisture beneath the floor. In this connection the foundation wall of concrete extending all the way around is advantageous since it prevents the ingress of moisture beneath the floor.

The objections that have been raised to the use of wood as a flooring material are the difficulty of maintaining the floor in good condition and its liability to rot from dampness underneath. The first difficulty can be overcome by using heavier lumber of a better grade and putting it in with the proper support. The second objection can be met with the statement that if proper ventilation is provided beneath the floor it will not rot. The reason that so many wood floors in cribs and granaries do rot is that rodents gain access to the space beneath the floor and in their burrowing pile up huge mounds of moist earth against the floor, when, of course, rotting will occur very rapidly.

If well done it is possible to use creosoted wooden floors, or at least to creosote the sills and under side of the flooring. A brush treatment will help, but in any event the treated lumber should be allowed to remain in the open air a couple of weeks before being put in place, so the odor will largely disappear.

Framing. The framing of a building for storing grain is equally as important as the foundation, because it is the framing which will have to withstand the lateral pressure; and as a matter of fact, 75 per cent of the failures of buildings of this kind are due to the bursting or racking of the walls because of insufficient rigidity. In the early days when lumber and labor were cheaper and many temporary structures were made, light framing consisting entirely of 2x4's or 2x6's served its purpose satisfactorily enough, though the depreciation was rapid and the effective life was seldom more than 12 or 15 years. It is to be deplored that this practice still obtains in many instances. Modern economy and efficiency should have changed this condition before now, but unfortunately practically the same framing is being used today as was used forty years ago, and it lasts only about as long.

Construction stronger and more durable than that in ordinary buildings erected for shelter is necessary in the case of cribs and granaries, which perhaps more than any other farm buildings are subjected to hard usage. A few of the principles and practices employed in barn building can be applied very advantageously in the construction of buildings for grain. Heavy stock of 6x6 or 6x8 stuff mortised and tenoned together will provide a framework for the walls which will give excellent and satisfactory support. Lighter stuff can be used in conjunction with the heavy stuff as will be indicated in the subsequent plans. Particular attention must be given to crossties and braces to prevent the bulging of posts and studs. Adequate support must also always be provided for overhead beams.

Walls. The walls of granaries are usually made of shiplap, either 6, 8 or 10 inches wide, or better of German or novelty siding or of drop siding. Plain square edged boards are sometimes used to wall up granaries, but this is inadvisable since shrinkage cracks between the boards are sure to appear and a certain amount of the grain will be lost. Nailing for the boards should be provided at intervals not to exceed 2½ feet in order to prevent bulging of the boards themselves; it is better to have the intervals 2 feet than 2½ feet. 10d wire nails are commonly used for nailing the boards to the studding and two nails should be used at each point.

Corn cribs are usually sided with 1x6 fencing or beveled siding, a 1-inch space being left between adjacent boards to provide for ventilation. The siding is usually put on horizontally and can be used more economically in this way, though sometimes in order to get a different effect it is put on diagonally. This, however, gives a longer unsupported section of the board and is not to be especially recommended in deep cribs.

Roofs. Most crib roofs have the ordinary construction of rafters, sheathing and shingles. This makes a very desirable type of roof since it gives excellent protection to the grain and since the roof itself will be more than ordinarily durable, for the pitch of the roofs on cribs is generally at least one-half. The purpose of using a steep pitch on roofs of grain storage buildings is to provide room for the installation of conveyor equipment in the upper part of the crib. The mistake should not be made, as is quite commonly done, of assuming that the roof will help hold the crib together. Its sole purpose should be to shelter the enclosed grain and the framing of the crib should be made strong enough to support itself and any load which is likely to come upon it.

General Arrangement. The labor of handling grain has become almost entirely mechanical. Formerly the height of the building was governed by the height to which a man could shovel grain, and on account of the labor and difficulty involved, cribs were seldom built over 12 feet high. The advent of the modern portable dump and elevator, manufactured in such a multitude of variations for both inside and outside installations, makes it possible to have bins 20 feet or more in height and still permit the filling of the bins to be accomplished with a minimum of manual labor.

In general arrangement the gradual evolution of the grain storage building which has occurred on the general purpose farms throughout the country has shown that the best type of construction is the double form, i. e., two rows of bins with a central driveway between. Of course, on small farms, and occasionally on large ones, granaries are sometimes constructed as small, single, separate buildings. Where a considerable amount of grain is produced, however, the first mentioned type is more generally to be found. In this general type the corn bins, if any, are located at the sides of the driveway, the driveway being made from 9 to 14 feet wide and with an overhead clearance of at least 9 feet which will give room enough for a loaded wagon and a driver. Above the driveway are located more bins, which are generally used for the storage of small grain.

As mentioned before, the portable dump is used to a very large extent for putting the grain into the bins. These

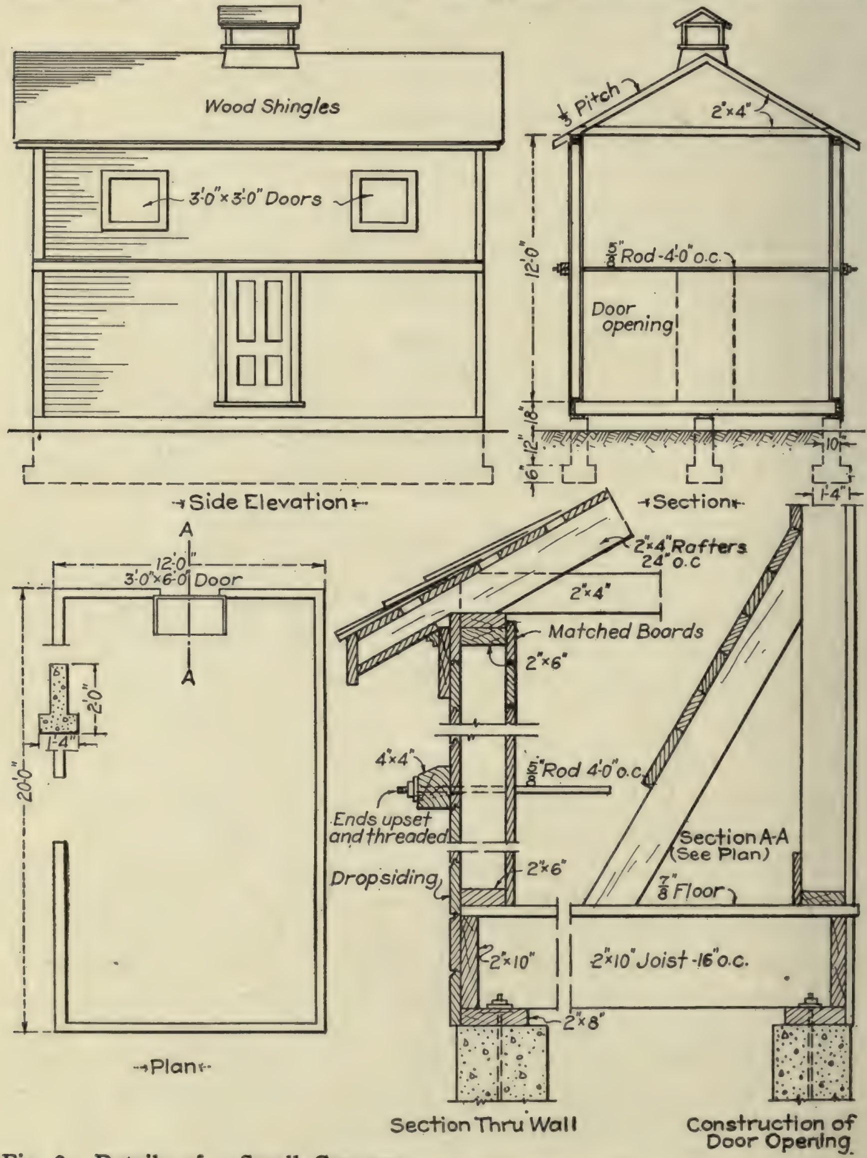

Fig. 3. Details of a Small Granary.

The lining of matched boards may be omitted if economy is necessary, but it is better to leave it. Depth of foundation wall may be varied to suit conditions. Grain is prevented from running out through door openings by means of removable louvers shown in Fig. 9. Small doors for shoveling grain may be located wherever desired.

dumps will handle either small grain or ear corn. The elevators conduct the grain to the top of the crib, from which it is distributed either by flexible spouts or horizontal conveyors to the separate bins. The installation of the dump and elevator can be either interior or exterior, the former being preferable when only one grain storage building is on the farm.

The emptying of the bins also is usually accomplished by mechanical means. In the case of the overhead bins above the driveway, openings provided with valves in the bottom of the bin will facilitate rapid loading of wagons beneath. In other cases where the bins extend to the ground, any one of several plans may be employed. In any case, a horizontal conveyor belt is used, which may be located outside the crib and the grain allowed to fall into it by the opening of small doors at the bottom of the wall. Some times provision is made in the building of the crib for the installation of the conveyor belt in the middle of the floor; this consists of a trench covered with loose boards placed crosswise on the trench. When the bin is to be emptied, the cross board at the end is removed and the grain allowed to run down upon the conveyor, more boards being removed as the bin is emptied.

A SMALL GRANARY.

The plans illustrative of the small granary shown in Fig. 1 can be adapted to a building of any reasonable size, provided proper consideration is given to the additional pressure which will result from increased depth. Essentially the granary consists of four walls which are strongly braced from side to side to prevent bulging, a solid, tight floor, and a good roof to protect the grain from the weather.

Upon a solid foundation extending around on all sides of the granary and on the central foundation wall are laid 2x10's on edges spaced 16 inches on center, upon which the floor consisting of matched boards is laid. The studs are placed at intervals of 2 feet. The plate consists of two 2x6's extending all around the building. The rafters are 2x4's. Tie rods are placed at a height of 6 feet from the floor, and just above the plate are located 2x4's to tie the walls together. In order to prevent the ends of the building from bulging it is necessary to put in ties lengthwise of the building also; these may be either of wood of 2x4 stock, or of ⅝-inch iron rods spaced four feet on center and located at the same height as the cross ties. A 4x4 placed outside of siding gives added strength and furnishes a bearing for the heads of the tie-rods. A stronger wall will result if joists are nailed to sides of studs, rather than toe-nailed to plate.

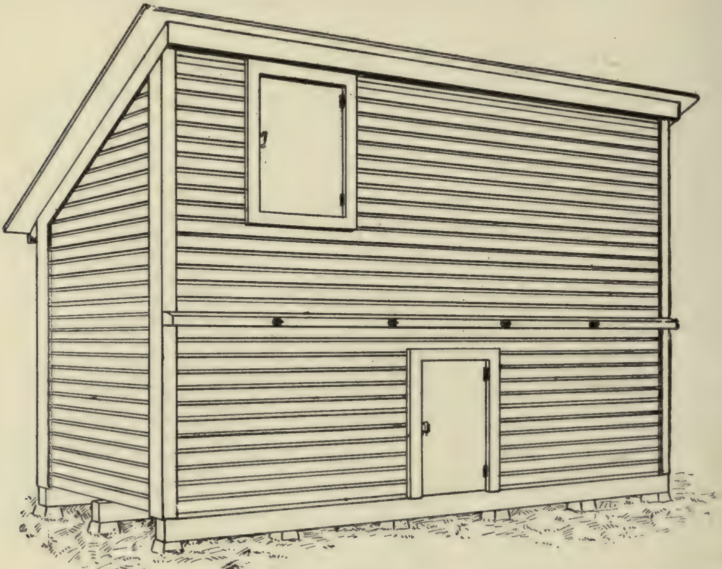

Fig. 4. Exterior of Small Corn Crib Which Holds About 1,280 Bushels.

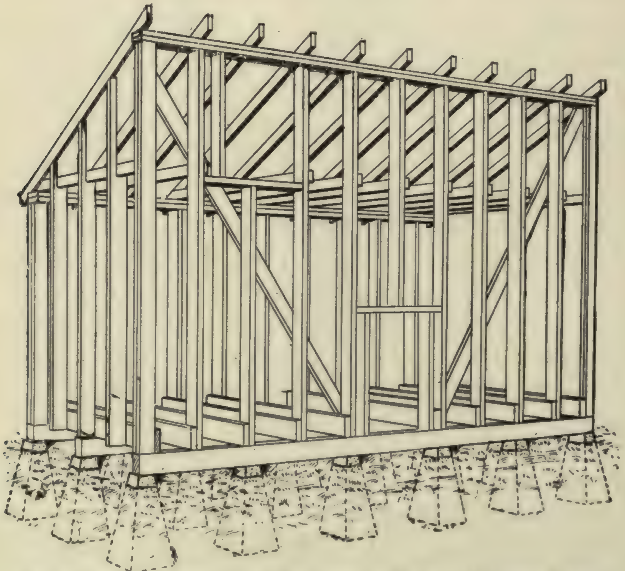

Fig. 5. Perspective of Framing of Small Corn Crib.

A cupola with louvers is part of the building. Small grain, especially that which is a little damp, will go through a "sweat" during which considerable heat is developed and it will be found advisable to have some means of carrying this away, which can be done through the louvers of the cupola. These louvers are usually 1x6 pieces set at a slant of 45°, with a two-inch perpendicular spacing between the pieces. The size of the cupola may be made to suit the size of the building, the best appearance being given if the cupola approximates one-tenth the building dimensions. For putting the grain into the building when a portable elevator is not used and when shoveling is practiced, it will be necessary to provide openings as shown in the elevation through which to shovel the grain. These openings can be covered with doors and the grain prevented from running out after the building is filled by setting in removable slanted slats or louvers as shown in the detail of Fig. 9.

It very often happens that the owner desires to remove a small quantity of grain occasionally for feeding purposes, and some provision must be made for this. The detail drawing of the door opening in Fig. 3 shows a very convenient device whereby this may be accomplished. The grain runs out through the open space at the bottom of the inclined wall. It is prevented from running out upon the ground by a small 4-inch board placed on the inside line of the studs, but ample room is provided for the insertion of the shovel so that the grain can be easily removed. It will also be found advisable to have a doorway arranged so that a person may get into the crib. This is accomplished by setting in removable louvers between the studs as described previously, a device with which almost every farmer and carpenter is familiar. All small openings between the rafters at the plate, between the sheathing boards at the outside rafters, etc., should be closed up to prevent birds from getting into the granary; a box cornice, as shown, will be effective. The cupola can be lined with a coarse meshed galvanized wire screen which will effectually exclude birds.

A SMALL CORN CRIB.

The plans in Fig. 6 illustrate the method of constructing a small corn crib more or less temporary in character to suit emergency conditions. If well constructed it will be found to be surprisingly durable, the main thing to be borne in mind being that thorough bracing to prevent bulging and racking is essential. The foundation consists of concrete piers at intervals of 4 feet. These piers are 6 inches square at the top, extending into the ground to a depth of 2½ or 3 feet and are 16 inches square at the bottom. Upon the piers are laid 4x8 sills and upon the sills joists of 2x8

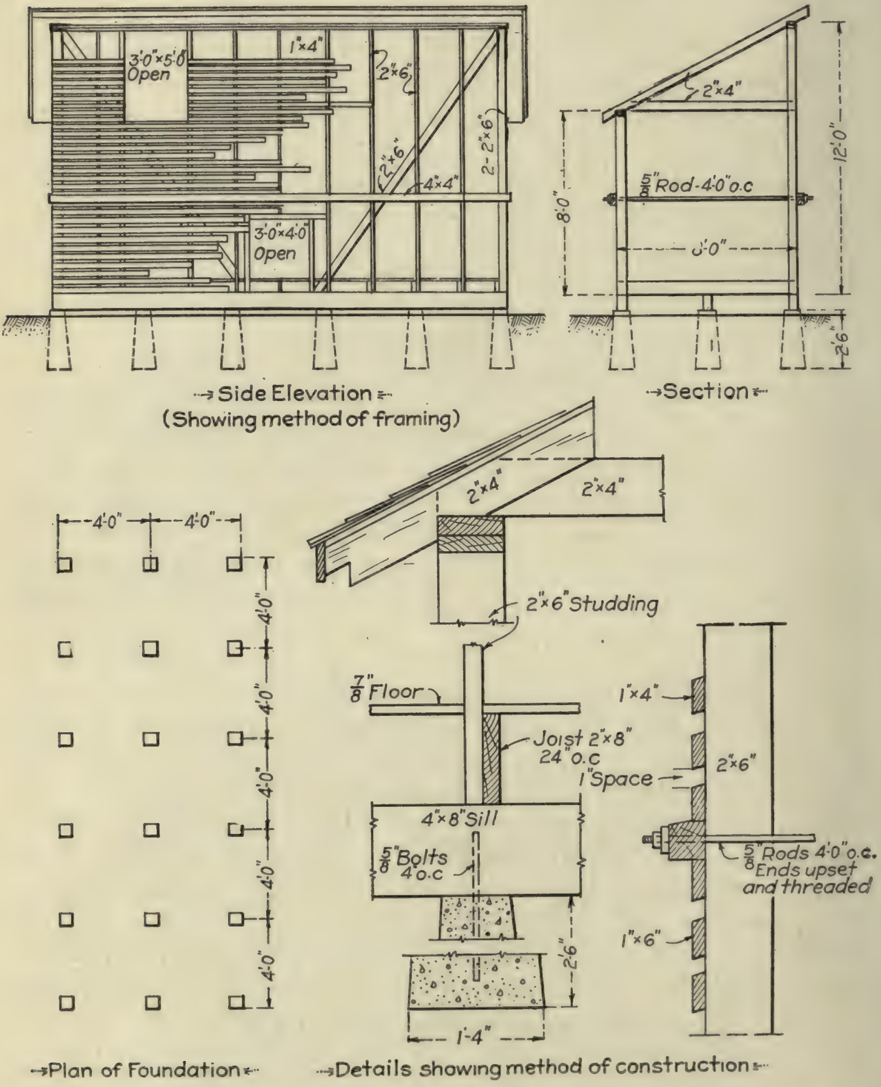

Fig. 6. Details of Small Corn Crib.

Piers take the place of foundation walls. Doors for filling and emptying may be located as desired; the four lowest boards may be nailed on cleats and hinged to open outward and upward, for emptying into a dragbelt along wall. Plain boards or beveled siding may be used for walls.

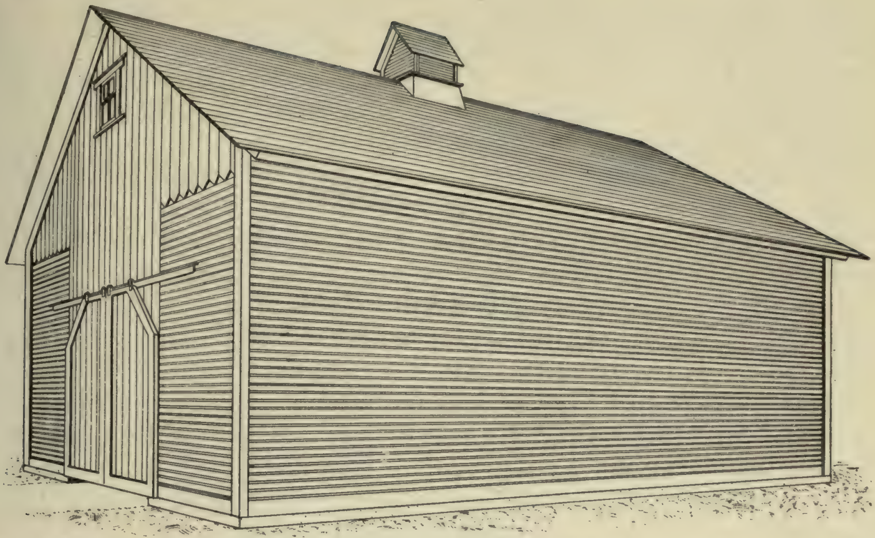

Fig. 7. Exterior of Large Grain Storage Building Which Has a Total Capacity of About 16,000 Bushels.

stock properly sized and placed 24 inches center to center. The studs which are 2x6 are nailed to every floor joist, making the distance apart of the studs 24 inches. The studs on the low side of the crib are 8 feet high, those on the high side being 12 feet. At a height of 4 feet from the floor four ⅝-inch tie-rods are put in and at the top 2x4's nailed to the

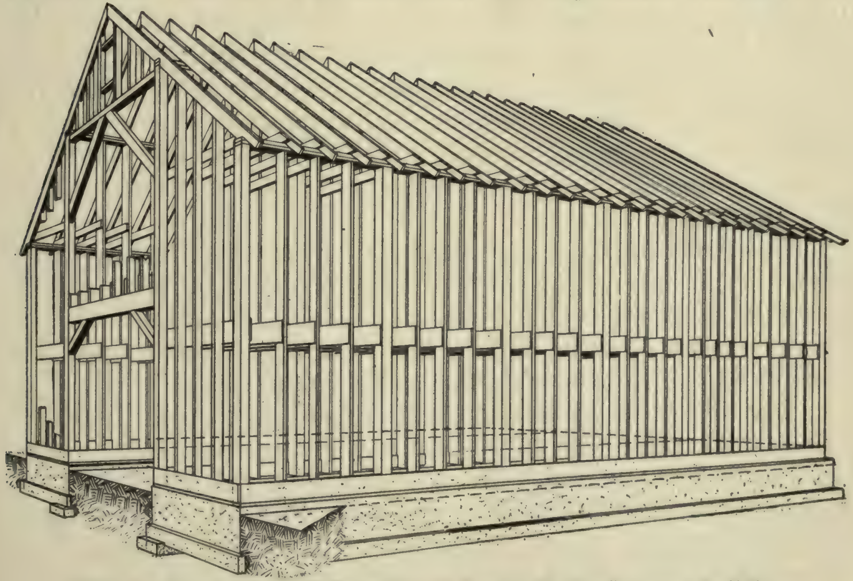

Fig. 8. Perspective of Framing of Large Grain Storage Building.

studs prevent spreading of the walls. If only a very temporary structure is desired, the roof may consist of boards and battens, but if the building is to serve for several years it should have a shingle roof. The floor may be made of plain square-edged boards 1 inch thick.

Sometimes the walls of a crib of this kind are made slanting so that the width at the bottom is 2 feet or more less than the width at the top. The purpose in thus slanting the walls is to protect the enclosed grain from water dripping off the eaves, but it is doubtful whether the advantage gained is worth while. The width of the crib will vary according to the locality from 6 to 10 feet. In eastern states it has been found impractical to have a greater width than 6 feet. In Indiana and Illinois, 8 feet is the common width, while in Nebraska at the end of the corn belt in a region where the general humidity is less, a width of 10 feet has been found to work satisfactorily.

A LARGE GRAIN STORAGE BUILDING.

In the heart of the corn belt some excellent corn cribs are being constructed. A particularly good one embodying a number of up-to-date features is shown in Figs. 7, 8 and 9.

The crib is double, each side being 9 feet by 48 feet, with a 14-foot driveway between. The walls are 16 feet high to the eaves, and a half-pitch roof is used. The steep-pitched roofs are desirable, since with a given wall height, the steeper the roof the greater the crib capacity. The high walls, too are an excellent feature; one can readily see the advisability of them when the only additional expense of the high wall is the additional studding and siding required, for the same roof and floor will serve for a deep as well as for a shallow bin.

The floor is laid on a concrete foundation, heavy foundation walls extending the full length of the building under each row of posts. On these piers is laid a 2x6 sill and on the sill 2x10 joists are laid 18 inches apart, to act as a direct support to the floors, which are of 1 inch stuff.

The framing of the superstructure is especially interesting. By referring to the floor plan in Fig. 9, it is seen that instead of the usual line of 2x6 studs, 2½ or 3 feet part, every fourth stud is replaced with a solid 6x6. These large timbers are 8 feet apart, and in between each pair are located three 2x6 studs, thus reducing the center to center distance to 2 feet, and affording an extraordinarily strong base for nailing the siding. The studs and timber for each crib are bound together by 1x12 ties at a height of 8 feet, and a 2x6 tie on the plate above every stud. One inch ties are used in the body of the crib because they interfere less with the settling and shrinking of the corn.

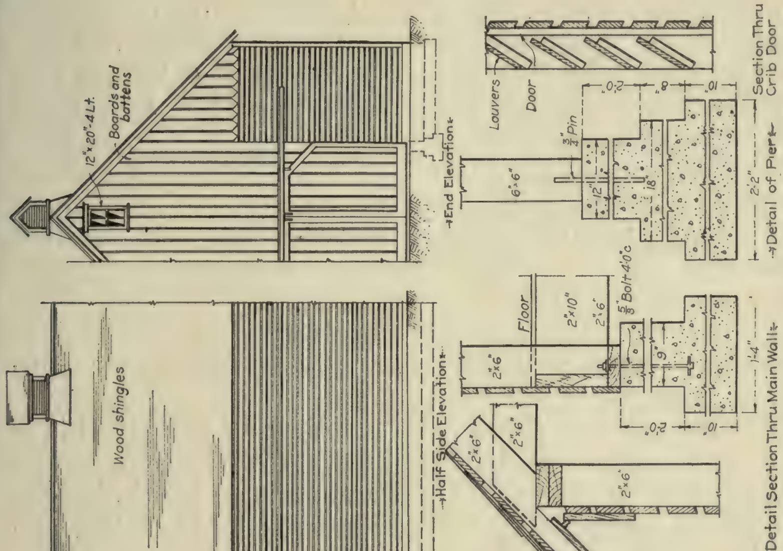

Fig. 9. Details of Large Grain Storage Building. A feature of this is the heavy framing that is used. Durability and permanence are assured. The main weight comes upon the inner foundation walls, which are made extra strong. The width of driveway may be varied as desired.

Each pair of 6x6 timbers on the inside of the building are framed together by means of a 6x10 extending across the wide driveway at a height of 10 feet, or just sufficient to give clearance to a wagon and driver, and a 4x6 just below the plate. They are mortised, tenoned and braced with diagonals exactly as barn framing is done. In this way extremely strong framing units are formed, which will successfully withstand the heavy racking and bulging strains to which a crib is subjected. Extending across the ends of the crib, both in the bins and above the driveway, are 4x6's mortised into the posts, to give stiffness to the ends.

An excellent small grain bin is provided by flooring the joists above the driveway with matched flooring and enclosing the sides with shiplap. The ends of this bin may be made sufficiently strong to resist lateral pressure by setting in 4x6's, which are mortised into the vertical end posts with the 6-inch dimension horizontal. Should the corn bins be empty when small grain is put in, the diagonal braces shown in the framing plan will prevent any bulging. This system of bracing will not interfere with the swinging of elevator chutes, for it occurs at 8-foot intervals only. The bottom of the grain bin may have several openings with slide valves and chutes to facilitate the emptying of the grain into wagons in the driveway below.

The corn bins are sided with 1x6 beveled siding; this is brought up on the *inside* of the studs above the floor of the small-grain bin, so as to admit air along the whole height of the wall up to the plate. Provision can be made for the installation of a vertical elevator within the crib.

The wide driveway is a feature that is not often seen, but it can be had at a very little extra cost. It can be used for a variety of purposes; it affords an excellent place to keep wagons and implements. Provided with a concrete floor it makes a first-class fanning floor; or if some hogs are kept a better or more convenient feeding floor cannot be had.

Each of the corn bins holds about 5,500 bushels, or a total of 11,000 bushels; while the overhead bin for small grain has a capacity of a little over 5,000 bushels.

This crib, instead of bulging, racking, sagging and finally collapsing in a short time, will stand for years, solid, substantial and durable. Good materials reduce the repairs to a minimum. Thirty or forty years of use should see the crib still standing in as good a shape as ever. And with all this, the cost is probably less than 50 per cent more than would be the case had cheaper methods been used.

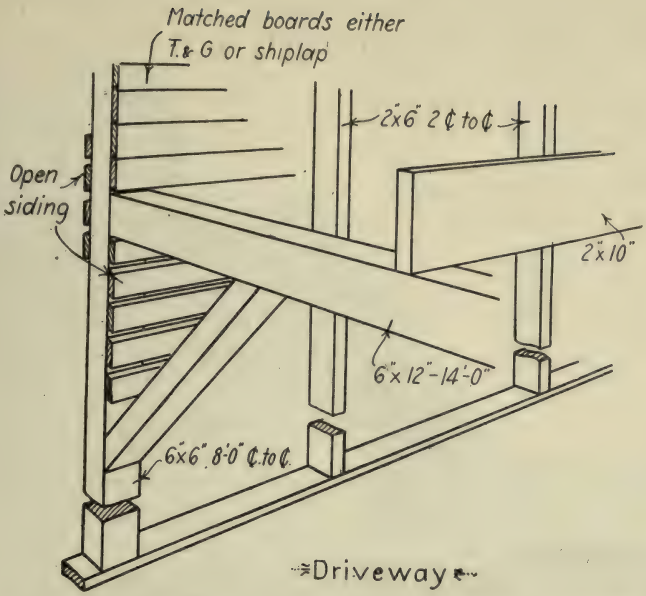

Fig 10. Framing Details of Large Grain Storage Building.

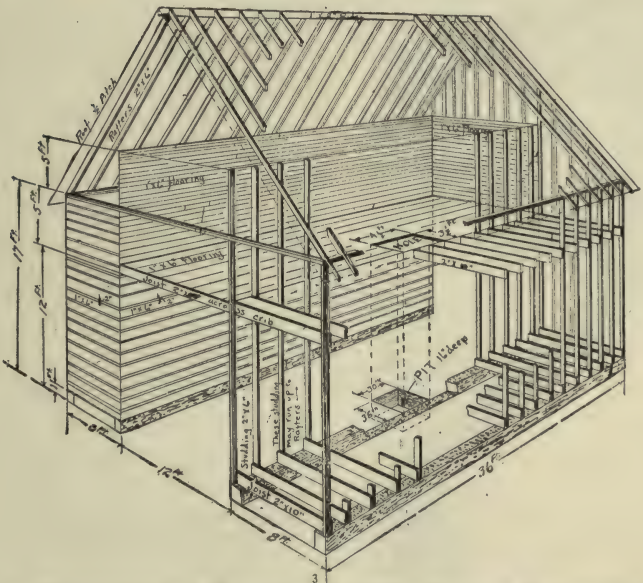

Fig. 11. Perspective of Framing of Grain Storage House Designed for Elevator.

Note:—The accompanying cuts and information relative to elevator equipment were furnished by courtesy of The Meadows Mfg. Co., Pontiac, Ill.

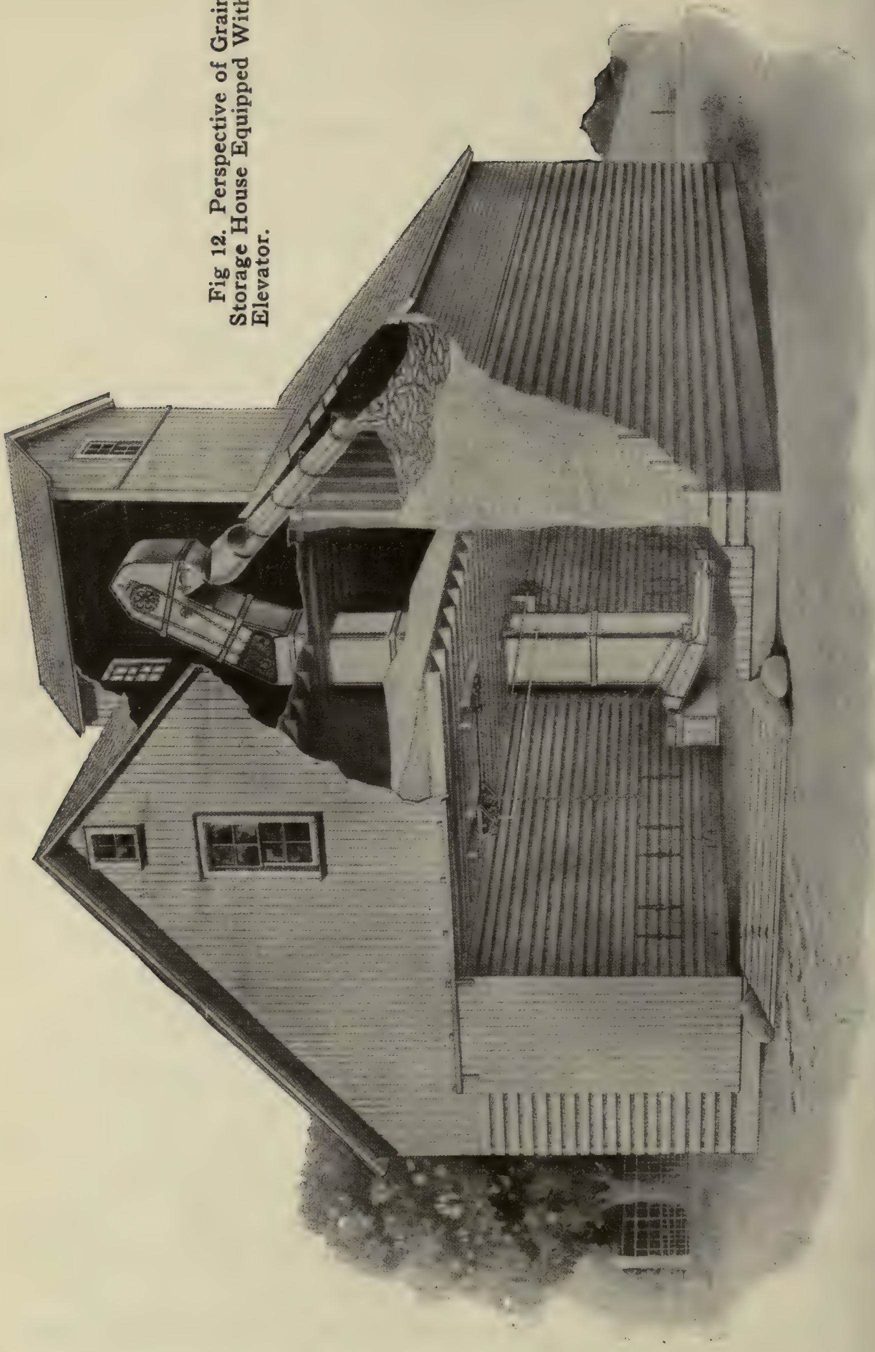

Fig 12. Perspective of Grain Storage House Equipped With Elevator.

GRAIN STORAGE BUILDINGS DESIGNED FOR ELEVATOR EQUIPMENT.

Where large quantities of grain are to be handled in a short space of time and with a minimum of effort, it is often advisable to install a mechanical elevator system. This could be done in the large grain storage building shown in Figures 7, 8, 9 and 10, although no special provision has been made for the pit or space for the elevator. A number of grain storage buildings have been designed with special reference to elevator equipment, and to show typical construction of this kind the two illustrations on pages 17 and 18 are presented. This grain storage building is of a different type than the one described on pages 14 to 16, being of lighter construction with smaller timbers.

The building shown in Figures 11 and 12 on the two preceding pages is intended to give maximum capacity at the least expense. With the dimensions as indicated, it has a capacity of about 4,758 bushels of ear corn and 3,740 bushels of oats or other small grain. It is the best economy in most cases to build not less than one-half pitch roof; if the roof is less than one-half pitch a cupola will have to be used to get full capacity. The 12-foot driveway in some cases may be narrowed to 10 feet, although the wider drive is more convenient and makes the capacity of the small grain bin about right in proportion to the corn crib. The absence of braces projecting into the driveway is an advantage in this building.

The sizes of material needed are shown in Fig. 11. If a large building is built the joists, studs, rafters and other framing members should be calculated for the larger size.

Other Farm Bulletins.

Other Bulletins in this series are upon:

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Horse Barns
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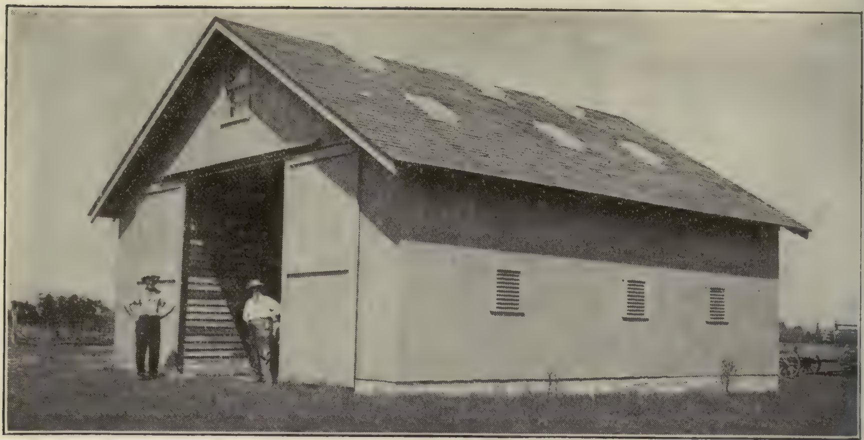

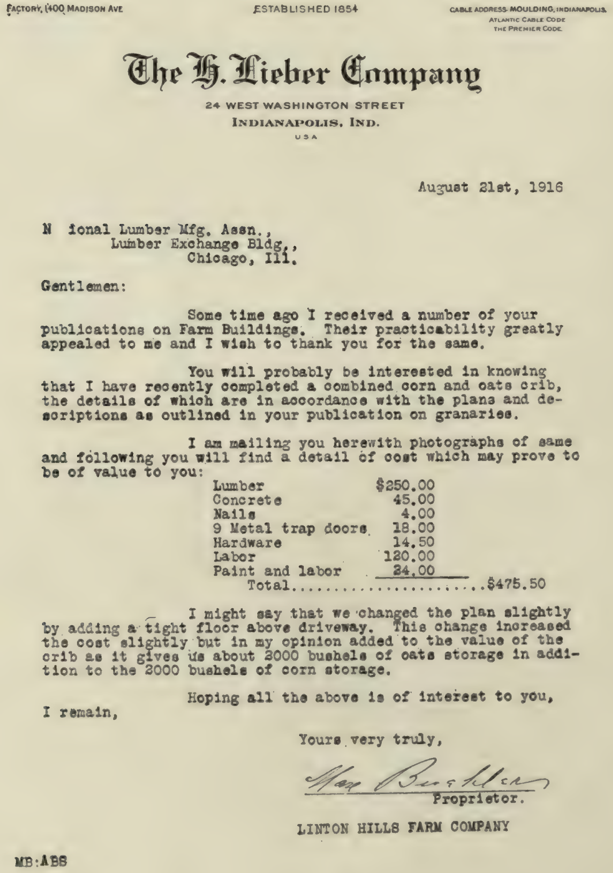

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August 21st, 1916

N ional Lumber Mfg. Assn.,
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Chicago, Ill.

Gentlemen:

Some time ago I received a number of your publications on Farm Buildings. Their practicability greatly appealed to me and I wish to thank you for the same.

You will probably be interested in knowing that I have recently completed a combined corn and oats crib, the details of which are in accordance with the plans and descriptions as outlined in your publication on granaries.

I am mailing you herewith photographs of same and following you will find a detail of cost which may prove to be of value to you:

Lumber	$250.00
Concrete	45.00
Nails	4.00
9 Metal trap doors	18.00
Hardware	14.50
Labor	120.00
Paint and labor	24.00
Total	$475.50

I might say that we changed the plan slightly by adding a tight floor above driveway. This change increased the cost slightly but in my opinion added to the value of the crib as it gives us about 2000 bushels of oats storage in addition to the 2000 bushels of corn storage.

Hoping all the above is of interest to you, I remain,

Yours very truly,

Proprietor.

LINTON HILLS FARM COMPANY

MB:ABS

The Preservative Treatment of Farm Timbers

by

By E. A. Sterling

Published by the
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MAY, 1916

General Series No. 22

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The Preservative Treatment of Farm Timbers

By E. A. Sterling

THE OPPORTUNITIES FOR TREATING FARM TIMBERS

Better farming means better and more permanent buildings and fences. Preservative treatment of a considerable portion of the wood material used on the average farm will give permanence and save the cost of replacing fence posts and parts of buildings, or even entire structures, because they have failed from decay. The advantages and opportunities along this line are very great, hence progressive farmers and dealers are interested in developing these possibilities to the fullest extent.

As is well known, the different kinds of wood vary greatly in their lasting qualities. Cypress, redwood, cedar, chestnut, white oak, the heartwood of dense grained pine, and several other species are naturally resistant to decay, but it is not always possible to obtain these durable woods. The unprotected sapwood on nearly all timber will decay when exposed to the weather, or where in contact wth moisture as in basement or ground floors, barn sills, fence posts, and many other locations. This natural tendency of some kinds of wood to decay can be prevented for indefinite periods, and at reasonable cost. Proper preservative treatment also makes wood serve practically every purpose for farm buildings, in preference to more expensive, less easily worked and less available materials.

Wood which decays most rapidly is in most cases the easiest to treat, hence the problem is simplified. The farmer can construct his buildings of almost any kind of wood with every assurance that they will last several generations, if the parts subject to decay or where non-durable woods are used, are properly treated. It remains for the average farm owner to acquaint himself with the preservatives and methods of treatment which from years of long experience have been found to be most successful. The treatment of timber is not experimental, but a thoroughly established practice.

The use of preservatives on the farm has in the past been confined largely to fence post treatment. The same excellent results, however, may be obtained from many other classes of material, the advantages in some cases being even greater with the sills and frames of barns and dairy houses, swine houses, and other structures where the cost and difficulty of replacement is greater than with fence posts. It has been so clearly demonstrated that wood can be made to resist decay indefinitely at reasonable cost, that the application of this knowledge will be of great value to all consumers of lumber for home building purposes.

It is advantageous for the farm owner and the local lumber dealer to work together in developing the use of treated timber. The dealer in most localities is in a position to sell wood preservatives in gallon, half barrel, or barrel quantities, and in some cases may treat timber for local farm use in an open tank in his own yard. He may also find it advantageous to carry a stock of brush treated or open tank treated lumber, small timbers and fence posts, since he could do the work more economically than the individual farmer. This practice would also permit the local dealer to purchase and sell local fence post timber, such as cottonwood and soft maple, which without treatment would not be durable. A further basis of mutual help is the advice which the dealer can give as to the kinds of wood to be used, and the methods of treatment. By carefully selecting the kind and grade of timber for the particular use it is often possible to utilize the lower grades, or non-durable lumber which would not commonly be used without preservative treatment, except where not exposed to decay.

Another possibility is the community or cooperative open tank treating plant, several farmers, for example, bearing the expense of a plant and perhaps purchasing their lumber or posts in quantities, and treating them at a central point. This permits the erection and use of a larger and more expensive plant than would be advisable for the individual farmer, and has the further advantage of buying the preservative in larger quantities. Here again the local dealer can be of assistance in supplying both the lumber and the preservative. A further source of help and information should be the State Agricultural College, experimental work having been done in several states, and several bulletins issued.

PRESERVATIVES.

The essentials of a good wood preservative are that it shall kill the low forms of plant growth, known as fungi, which cause the decay of wood; remain liquid at ordinary temperatures, and penetrate at least the outer surface of the wood; be permanent to the extent that enough remains to give continuous protection; and be safe to handle and use, there being no necessity for using anything poisonous nor explosive. In addition to the essential characteristics of the preservative itself, it should be of reasonable cost.

Coal Tar Creosote is the best preservative known for treating farm timbers. It prevents decay and is lasting in its results, because it combines in a large measure the essentials of the ideal preservative. There is some loss by evaporation of the lighter less valuable portions, but creosote is practically insoluble in water, remains liquid at ordinary temperatures, and satisfactorily penetrates most kinds of wood. It is comparatively cheap and safe to use under nearly all conditions. Where the odor would be objectionable exposure to the air for a time will render it less noticeable. Creosoted surfaces should not be painted, nor is it necessary because the oil itself gives a rich dark brown color to the wood, and in most situations where used painting is not needed.

Such excellent results have been obtained from the proper application of creosote that for many years it has been widely recognized as the standard preservative for general use. Although used to the extent of over 125 million gallons a year, its application to farm timbers has been limited because it has not always been available in retail quantities. Furthermore, the commercial creosote used for the pressure treatment of railroad ties and large timbers is not always best for brush and open tank treatment. Whenever possible what is known as a high boiling, high gravity creosote should be purchased for farm timbers. This simply means a special oil or one corresponding to the highest grade crude creosote, which is heavy and has a low percentage of parts which evaporate at low temperature.

Tar, Crude Oil and Wood Creosote have been used but the first two are not recognized as wood preservatives, and good results can not be expected from their use. They are not sufficiently poisonous to the organisms which cause decay; the tar does not penetrate the wood appreciably; the crude oil has no value unless the wood is kept saturated and waterproofed with it. Their use is not recommended, at least by the methods of treatment which can conveniently be carried out on the farm. Wood creosote has qualities

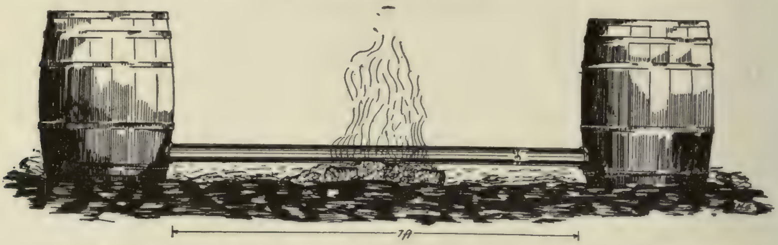


FIG. 1. AN EASILY BUILT HOME MADE OUTFIT.—This outfit is inexpensive, consisting of 2 tight wooden barrels, 7½ ft. of 3-inch pipe, 4 3-inch lock nuts, and 4 3-inch rubber gaskets. Its capacity is 20 posts per day, open tank treatment. With 2 more barrels for treating with cold creosote, the capacity could be doubled.

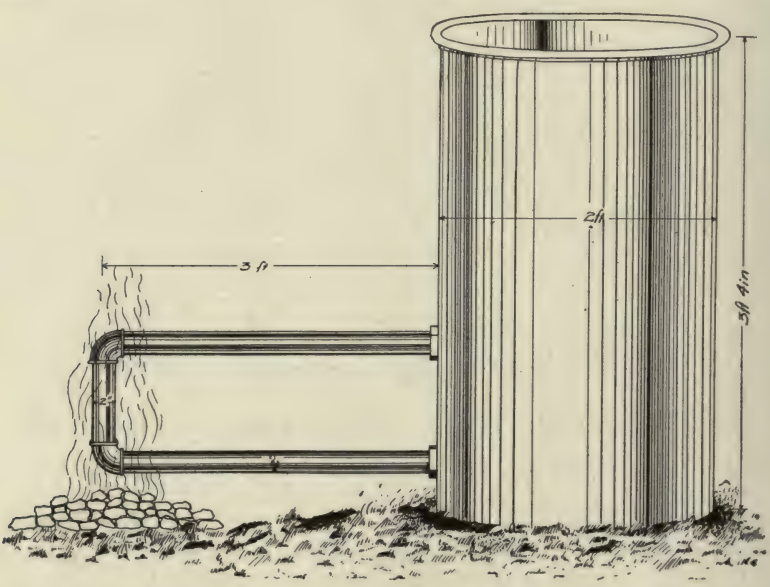


FIG. 2. A TWENTY-POST CAPACITY TANK.—This tank is galvanized iron, 24 gauge, and fitted with pipes as shown should cost about $8. Its daily capacity, 20 4½-inch posts, butt treatment, could be doubled by providing a second tank.

—Courtesy of Iowa Agricultural Experiment Station.

which indicate a preservative value, although it is still in an experimental stage as regards its application to farm timbers.

Paint, Linseed Oil and White Wash can not be expected to give good results as preservatives, as they do not penetrate the wood and do not prevent decay. Good paint in itself, by keeping out air and moisture, gives excellent protection to wood surfaces, and farm buildings should be kept well painted, but paint is not a wood preservative in the sense the subject is considered here. If wood is kept saturated with linseed oil, decay may be retarded by keeping out the water, but this would be difficult as well as too expensive. White wash has no preservative value whatever.

Mineral Salts, especially zinc chloride, have been extensively and successfully used as wood preservatives, but as far as known are not recommended for the small consumer, or on farm timbers. Most of them are not effective when applied superficially.

Proprietory or Patented Preservatives, consisting of chemical solutions or mixtures of various kinds, have been quite extensively sold. Some of them, particularly those containing creosote, have high value as preservatives. Others are practically worthless, despite extravagant claims. The high cost is the worst drawback to the patented preservatives of merit. They are rarely superior to good creosote, and often not as good, and their cost is often out of proportion to their relative value.

A Word of Warning may prevent a consumer who buys preservatives in retail quantities from being confused or misled by the many preparations offered. There have not been any new preservatives of established value discovered nor developed for many years, hence anything which is offered under a new trade name is either a new material of unproven value, or a combination of well known materials. Coal tar creosote and zinc chloride are the standard preservatives used in railroad and commercial plants, and the men in charge of these operations will be the first to discover and use something which has greater value. Since the effectiveness of zinc chloride depends on thorough impregnation of the wood, and as the only feasible method for the small user is open tank or brush treatment which gives superficial penetration, the obviously safe and reasonable course for the man who buys preservatives by the barrel for

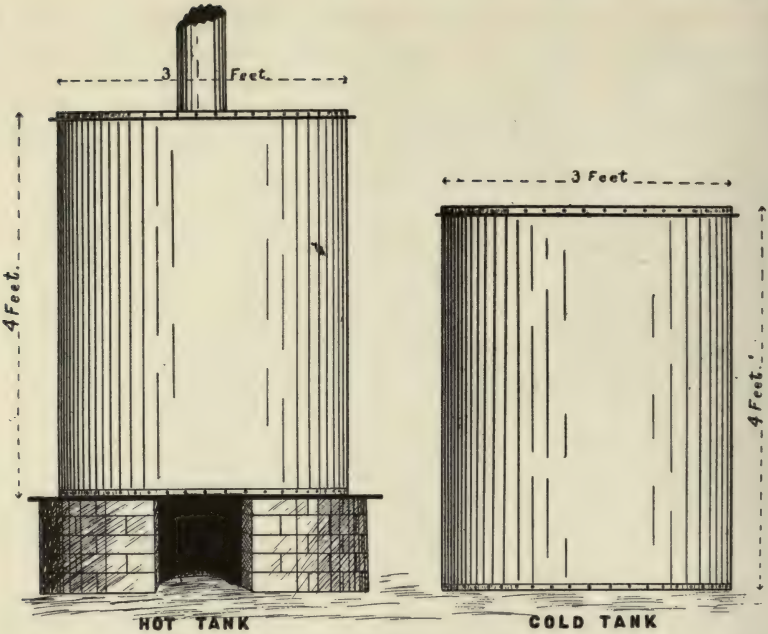


FIG. 3. TWO-TANK EQUIPMENT WITH CAPACITY OF 60 TO 75 POSTS DAILY.—This equipment would be suitable for a large farm or a coöperative plant for the treatment of a comparatively large number of posts. The cost complete should not exceed $12 to $20.

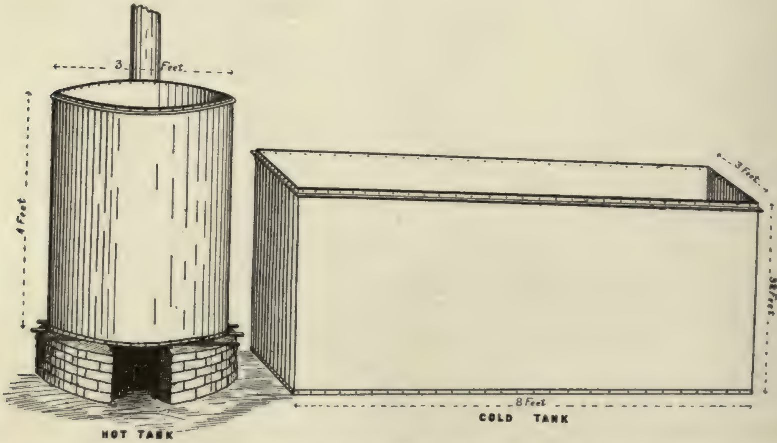


FIG. 4. TREATING EQUIPMENT WITH ROUND AND RECTANGULAR TANKS.—The long tank is for treating the entire posts in cold preservative after the regulation butt treatment. It is large enough to allow the cold treatment of a large number of posts at one time. The small tank for heating the preservative is of heavy galvanized iron reinforced with angle iron. The large tank is of heavier iron. Two rectangular tanks, one being over a brick fireplace for heating, may be used for short lengths of lumber.

—Courtesy of Iowa Agricultural Experiment Station.

home use is to use the best creosote he can get. This may mean buying it as creosote or under some trade name, but the result is the same, provided it has the guarantee of a responsible manufacturer that the oil is derived wholly from coal tar.

In the matter of cost, it is a safe rule to question a charge of more than 50 cents per gallon in barrel lots, and in most regions this is more than it should be necessary to pay. Commercial grades of crude creosote should not cost in barrels over 25 cents per gallon; while special grades of creosote for brush and open tank treatment from which the lighter oils and the salts which crystallize in cool weather have been eliminated, should be obtained for not over 30 to 45 cents per gallon, and in some cases less. Freight rates add materially to the original cost, so that in regions remote from producing centers, a large percentage of the delivered cost is represented by transportation charges. The only opportunity the small consumer would have to obtain good creosote under 20 cents per gallon would be if he was located near enough to a commercial plant to obtain barrels of oil direct, without the cost of transportation and handling.

PREPARING THE TIMBER FOR TREATMENT.

Timber should be thoroughly air seasoned before treatment. Care should be taken to remove every bit of bark from the posts or other round timber to be treated, as its presence retards and sometimes entirely prevents the penetration of the oil. The seasoning is best accomplished by piling the timber in open piles, raised off the ground, in such a way that the air can circulate freely around every piece. Timber should never be left on the ground to season.

METHODS OF TREATMENT.

The Open Tank Process consists of heating the wood in the preservative for one or more hours, at a temperature of about 200 degrees Fahrenheit. It is then quickly transferred to a tank of oil having the temperature of the air and left for one or more hours. In the hot bath the wood is heated and the air and moisture in it expanded. When it is plunged into the cool oil, the air and moisture contract and draw the oil into the wood. Instead of using a cool bath, the heating of the oil in the hot bath may be stopped, and the wood and oil allowed to cool together. This accomplishes the same result as the cool bath, but since the hot oil cools slowly a longer time is required. When this method is used the wood is frequently allowed to remain in the oil over night.

It is desirable in the open tank treatment to have the sapwood entirely penetrated with the oil. This is sometimes difficult to accomplish and a shallower penetration must then be accepted. A penetration of one-half to three-fourths of an inch will give very good results, and even lighter penetrations, while they are not as desirable, will give sufficient protection to more than pay for the cost of treating. With fence posts the treatment should extend up far enough so that at least 6 inches of treated wood will be above the ground line when the post is set.

The length of time the wood is held in the hot and cool bath should be determined by the penetration obtained and the amount of oil absorbed. The penetration may be determined by boring a small hole, this hole to be plugged with a creosoted plug before the post is set, or the timber used. If the penetration is not sufficient the hot bath should be lengthened. If the penetration is satisfactory, but too much oil is absorbed, the cold or cooling bath should be shortened. Some woods treat more readily than others, so a general rule can not be given.

The sapwood of most species treats more readily than the heartwood, so sap lumber is preferable and round posts are more suitable for treatment than split posts in which heartwood is exposed.

The amount of oil absorbed by fence posts will vary with different kinds of wood and the size of the posts. In general, it will be between four-tenths and six-tenths of a gallon. In estimating the amount of oil necessary to treat a given number of posts, enough oil to fill the treating tanks to a height of about two feet should be added to the amount to be absorbed by the posts. This amount of oil will, of course, be left after the posts are treated.

The Apparatus for the Open Tank Treatment consists of one or two tanks (depending on whether the hot and cold or hot and cooling method is used), thermometer, and some means of heating the oil. The chief requirements of the tanks are that they (1) shall be strong enough to hold the weight of oil and timbers, (2) shall not leak, (3) shall be deep enough so that the top of the oil will be a foot or more below the top of the tank during treatment, and (4) can be readily heated. Any metal tank of convenient size which will satisfy these requirements will do the work. It is advisable to have a false bottom in the tank for the timber to rest on. The heating may be accomplished by a fire beneath the tank or by means of steam coils, if steam is available. If an open fire is used care should be taken to prevent the oil slopping over the side of the tank and taking fire. This is the reason for having the top of the oil a foot below the top of the tank. While the oil is not dangerously inflammable, and ordinary care will prevent trouble, carelessness may result in the loss of the oil and the timber. The treatment should, of course, be made in a situation where an accidental fire will not endanger any buildings.

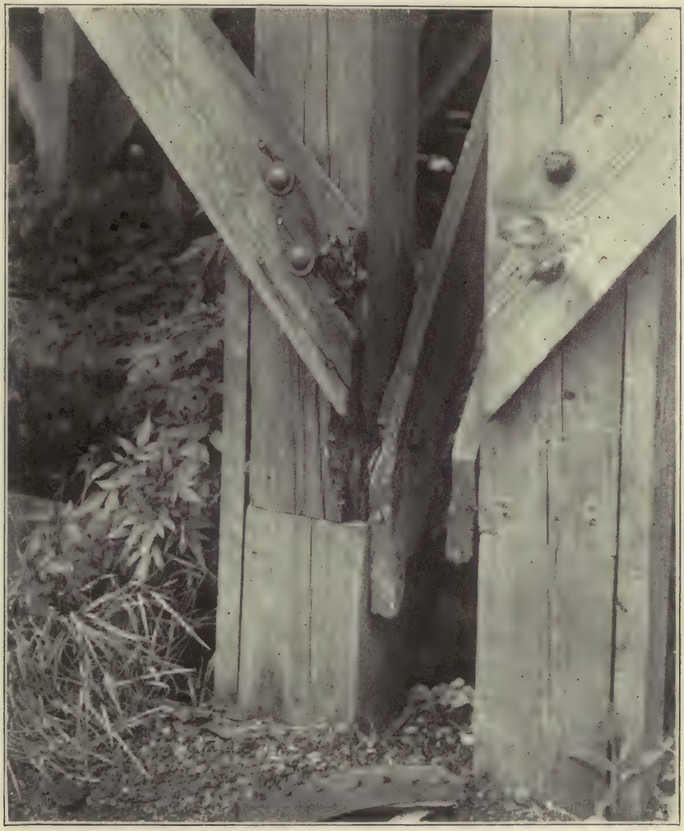
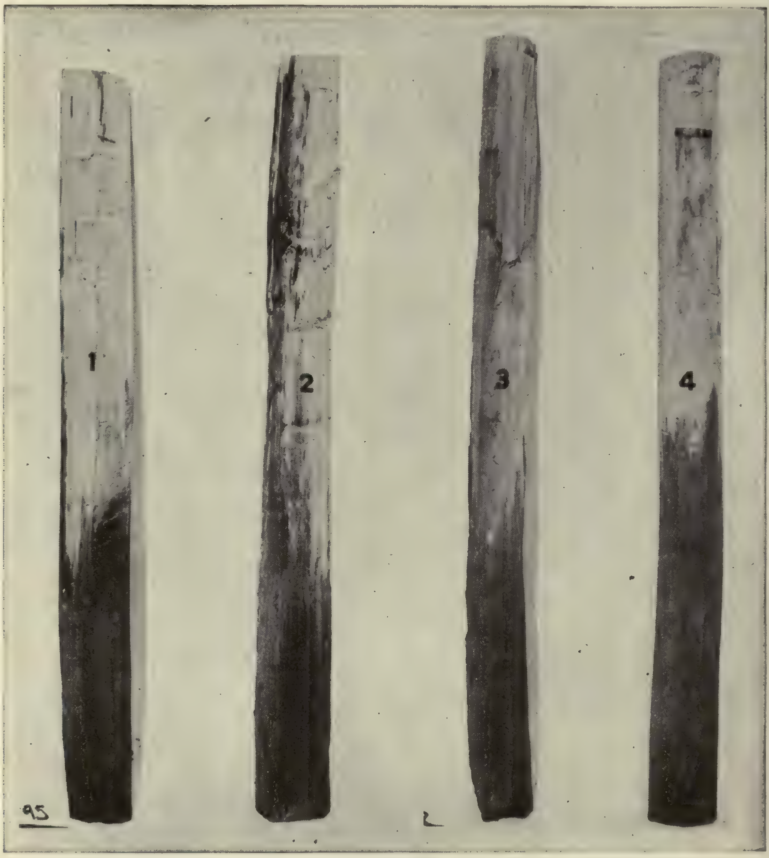


FIG 5. AN EXAMPLE OF ORDINARY DECAY.—Such decay of wood at joints and in exposed places can be entirely prevented by proper preservative treatment.

The Dipping Process consists in simply heating the wood in the creosote for 15 minutes or longer. This allows all checks and defects to become filled with oil, but the penetration and absorption of oil are slight. On account of the small amount of preservative used and the large amount of material that can be treated in a day, it is cheaper than open tank treatment, but it is also much less effective. It should never be used except on thoroughly seasoned timber. This



Courtesy of Iowa Agricultural Experiment Station.

FIG. 6. CREOSOTED COTTONWOOD POSTS AFTER 9½ YEARS' SERVICE.—Since cottonwood is one of the woods which decays most quickly when in contact with the ground, this illustration of creosoted posts which are still in perfect condition after 9½ years indicates the effectiveness and possibilities of creosote treatment. It applies equally well to lumber and many other farm timbers and enables both the dealer and the consumer to make use of woods which are not naturally resistant to decay. Experience shows that timber which is well enough treated to be sound after 10 years will last 10 or 15 years longer in situations where there is no wearing away of the treated portions of wood.

treatment will in most cases add sufficiently to the durability to fully justify the expense, though it is not so highly recommended as the open tank method.

The Brush Treatment or Painting Method consists in applying two liberal coats of hot preservative to the wood. The oil should be heated to about 200 degrees Fahrenheit and flooded over the wood rather than painted upon it. Especial care should be taken to fill every check and defect in the wood, and the first coat should be allowed to dry completely before the second coat is applied. Only thoroughly seasoned timber should be treated. This treatment is even less effective than dipping, but will retard decay long enough to pay for itself. In all cases the timber should be so handled after treatment that the treated wood will not be scraped off, exposing an untreated surface. Where such accidents happen, the scraped surface should be painted with creosote before the timber is used.

KINDS OF TIMBER SUITABLE FOR TREATMENT.

Almost any kind of non-durable wood will be benefited by treatment. The species most suitable, however, are those which treat most readily, especially the sapwood. The heartwood in few will absorb much oil, but it is not usually necessary because it is itself durable. In the treatable class are the pines, Douglas fir, tamarack, western larch, red oaks, pin oak, beech, elm, gum, red maple, sycamore, tulip, and a number of others. Such woods as locust, catalpa, western juniper, redwood, cypress and cedar are very durable without treatment and the use of creosote is not justified. The sapwood of most of these species, however, is not durable, and posts or lumber which consists mostly of sapwood should, therefore, be treated.

SITUATIONS IN WHICH TREATMENT IS DESIRABLE.

The treatment of fence posts is quite general, but there are many other forms of timber used on the farm, to which treatment can be advantageously applied, such as sills and foundation timbers, bridge timbers, board walks, wooden gates, windmill frames, floors of stalls and passage ways for stock, together with joists and framing under such floors. Timber in contact with concrete, as on foundation walls, is likely to decay and should be treated. It is often recommended that the walls and floors of chicken houses be painted with creosote to check the spread of chicken lice; while creosote on the scratching floors will keep down the dust. It is also believed by some that creosoted swine houses will help prevent the development or spread of hog cholera, because creosote is an antiseptic. In fact, any non-durable wood used in exposed places, on foundation walls, or wherever experience has shown that the conditions are favorable to decay, may well be treated.

The durability of shingles will be greatly increased by creosote treatment. It not only prevents decay but keeps the shingles from "fuzzing" and curling in dry weather. In cases where cistern water is used for drinking, the creosote from the shingles may give it an unpleasant taste for a time. This can be very largely avoided by allowing the shingles to season several weeks after treatment before laying them, or by diverting the water from the cistern until the taste disappears.

The treatment of silos is also advisable. Experience indicates that the silage is not contaminated by the creosote, and cattle seem to find no taste or odor which is objectionable. The staves where possible should be treated and allowed to season several weeks before erecting the silo, or the silo allowed to stand for a time before being filled.

When farmers' cooperative telephone lines are constructed the treatment of the poles would effect a large saving in the cost of upkeep. For this purpose the brush treatment will generally be found the most suitable, since the number of poles to be treated will be comparatively small. The open tank treatment will, of course, give a much longer life than brush treatment, but the cost of the tanks, the extra oil required, apparatus for handling the poles, and the extra labor may not be justified unless a large number are to be treated. Pole braces should be butt treated like the poles, and the roofs and mortises in the poles painted liberally with creosote.

In all timber construction exposed to the weather, where wood comes in contact with wood, stone, concrete, or other material, moisture collects and decay usually begins at the point of contact. The wood should be painted liberally with creosote wherever it touches other material in this way. If two pieces of wood touch each other, the creosote should be applied to both.

THE COST AND THE SAVING.

Little is gained by attempting to estimate in detail either the cost or the saving from preservative treatment of farm timbers. The actual figures available for different kinds of treatment of given woods under local conditions may be misleading rather than helpful. The cost of the timber and labor and creosote varies greatly in different communities. We find, for example, in Bulletin No. 158 of the Agricultural Experiment Station, Ames, Iowa, that the saving from creosoting soft maple posts is about 2 cents per year, based on the post costing 5 cents, treating with creosote 13½ cents, setting 8 cents, and a life of 27 years against 4 years untreated. Cottonwood posts under the same conditions show a saving of about 3½ cents per year. These results might not apply in other regions. The cost of treatment alone usually averages from 10 to 20 cents per post, depending on the cost of the creosote.

In lumber and small dimension timbers the condition is the same, the variation in expense being caused by the method of treatment, the kind of wood, and many other factors. A thorough brush treatment of lumber should not cost over $5 per thousand board feet; while open tank treatment, if facilities are available, might run as high as $10 per thousand, or even more. These approximate figures are simply a guide, and will vary within wide limits.

The best plan is not to figure too closely on detailed estimates of cost, but proceed on the ground that the initial expense is fully justified by the longer service the timber will give. A barrel of good creosote oil at a cost of approximately $15 or $20 is certainly a good investment, and if available, can be used to excellent advantage from time to time. Where a large amount of material is to be treated it is, of course, necessary to purchase the preservative in proportion to the work done. Every farm should have at least a small supply on hand for the odd jobs of repairing and building which continually occur.

The saving is another point which does not need to be reckoned closely, since it is so certain that satisfactory results will be obtained. From the many cases where pressure creosoted timber has shown no signs of decay for 40 years or more, down to the extra life which a light brush treatment will give, many gradations in results are obtained. There is no question as to the economy of a creosoted cottonwood post, which lasts 20 years, when one without treatment decays in three or four, nor of having sills, basement flooring, fences, gates and lumber in many other forms last at least two or three times the normal life.

The most enthusiastic advocates of treated material are those who have used the largest quantities. Most of the large railroads of the country creosote their cross ties and bridge timbers, and from this large use down to the smallest consumer, results are almost invariably obtained which are in keeping with the thoroughness and care with which the work is done. By creosoting all farm timbers exposed to decay, and by using reasonable care to secure at least a uniform coating or penetration, a saving will result which will make for economy, permanence, and attractiveness of nearly all farm structures.

Other Farm Bulletins.

Other Bulletins in this series are upon:

Dairy Barns
Horse Barns
Swine Houses
Poultry Houses
Farm Residences
Implement Sheds
Ice Houses
Silos
Garages
Grain Storage Buildings

Ask for those that will be helpful to you.

6

Hog Houses

by

K. J. T. Ekblaw

PROPERTY OF DIVISION OF
FORESTRY
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UNIVERSITY OF CALIFORNIA

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Hog Houses

By K. J. T. Ekblaw

The extent to which swine increase the net return from the farm is well recognized by most farmers. On a properly conducted farm, especially in the corn belt, swine are practically clear profit aside from the cost of the labor in caring for them, since their food can be made to consist largely of waste products. Hog raising has probably returned proportionately greater profits to the corn-belt farmer than any other enterprise. In view of this, it might naturally be expected that the hog would be the best housed animal on the farm. In the majority of cases, however, the opposite is true. The old-fashioned idea that the hog is a tough, filthy animal still exists, and many farmers believe and act in the belief that anything is good enough for a hog.

As an actual fact, there is no farm animal that needs care and protection more than the hog. The horse and cow are protected by a heavy coat of hair in the winter time; even the calf or colt will grow a good fur coat when exposed in winter. Chickens have a thick layer of fluffy feathers which keep even their small bodies warm, but a hog has nothing except a thin coat of stiff hair between his skin and the cold. Little pigs farrowed in cold temperature with no shelter generally die, and even if they live never thrive at all well.

Swine raising as a business is bringing about an improvement in housing conditions. Progressive farmers and hog raisers realize the money returns coming from proper protection for their hogs, and have designed shelters which provide the maximum of comfort and convenience at a minimum of cost. While these structures are to be found principally on farms where hog raising is the chief business, they can easily be so changed in plan or size as to meet the needs of general purpose farms where hogs are but part of the total income.

The most important points in hog house construction are comfort for the animal under all conditions, convenience for the care-taker in feeding and handling them, and good sanitation. The house must provide sufficient warmth in cold weather to keep the swine in good condition and still allow shade on the hottest days of the summer. It must be so arranged as to permit feeding the hogs easily and quickly, and of handling them with the least amount of disturbance. Sanitation is very necessary and attention paid to it will be amply rewarded later in healthier swine and, consequently, greater financial returns.

The successful hog house is built to include such arrangements as will do away with disease instead of developing it, as is often the case. Since most of the diseases which seriously affect swine are germ diseases, it follows that the construction which will prevent the entrance and development of germs is the best. Sunlight is one of the commonest, most effective and cheapest germicides known. The hog house should be provided with a maximum amount of sunlight at times when it is most needed.

With good, warm buildings it is possible for successful hog raisers to have their sows commence to farrow about March first. In order to have pigs large enough for the fall demand, breeders find it necessary to have their pigs come about this time and even producers of market hogs find the practice very profitable. Several marked advantages belong to the early pigs. First, early in March there is usually more time to care for them. Second, by the time the pastures are ready the pigs are large enough to begin to eat, hence they get the longest possible pasture season and can thus be expected to make better gains from grass than will the later pigs. They can be kept on pasture until ready for market or nearly so. Not only can they make more use of pastures, but they can make more economical use of all feed, because they can be finished for market before cold weather sets in, when feeding is more expensive. Should crowding of the pigs occur, some of them can be marketed by the last of October, and market figures indicate that for the last ten years the October prices have averaged considerably higher than the December prices.

Unless a good house is at hand, two litters cannot be raised to advantage, because the spring pigs must be put off so late that the fall litters do not get well started before cold weather. Most farmers do not feel that they can keep an old sow for one litter, but with two litters it becomes an entirely different proposition. It is generally admitted that old sows raise better pigs than young ones and the keeping of old sows enables the hog raiser to select and keep only the best producers.

The selection of the best possible hog house is largely a problem of local conditions. Thought must be given to the various factors connected with the actual use of the house in question. By studying the best points of the ideal house and the advantages of the proper location, it is easier to better judge as to comparative values of different types. The following abstracts from a bulletin on "Movable Hog Houses," by John M. Evvard and J. B. Davidson, published by the Agricultural Experiment Station, Iowa State College of Agriculture and the Mechanic Arts, Ames, Iowa, will be of service in this connection.

THE ESSENTIALS OF AN IDEAL HOG HOUSE

"The satisfactory house for hogs should possess these requirements:

"**Warmth**—The newly farrowed pigs especially demand protection. Early pig production is impossible without warm shelter. Stock hogs thrive best when they are not compelled to 'shiver' from cold and thus burn up feed which would otherwise be converted into tissue. The wintering sow makes good use of a warm sleeping bed. In truth, all classes of swine demand reasonably warm shelter if maximum returns are expected. Sudden wide ranges of temperature are to be avoided.

"**Dryness**—To expect thrift in damp, musty quarters is not logical. The dripping of condensed moisture from roof and walls is seriously objectionable. Metallic constructions are open to deserved criticism in this respect; wooden inside sheathing helps considerably. Masonry unless built with hollow air space is somewhat liable to cause this undesirable condensation. A dry, well-drained floor, as well as dry, tight roof and walls, are all essential.

"**Abundance of Light and Direct Sunlight**—Without sunlight we cannot have a profitable swine husbandry. It is the great and universal germ destroyer and kills disease-causing organisms. It promotes dryness, warmth and ventilation, thus bettering hygienic conditions. Direct sunlight gives suckling pigs vigor and strength. Direct sunlight should strike each part of the interior of the house at some time during the day; and the pens should be well sunned, especially in the farrowing months of February, March and April. The forenoon sun has unusual value, coming as it does immediately after a relatively long, dark, and ofttimes cool and damp night, so weakening to young and suckling pigs. In the hot summer months some shade should be provided to ward off the direct sun.

"**Shade**—The hog actually suffers more from the heat of summer than he does from the cold of winter; he should be protected from both. Feed is wasted in overcoming both extreme cold and severe heat. High temperature dulls the appetite so essential for profitable pork production. Hogs ofttimes die under the direct rays of the summer sun.

"**Ventilation**—The hog demands an abundance of fresh, pure air; this may be easily provided without subjecting him to injurious drafts. Summer coolness is dependent largely on good ventilation. The hog suffers much in a closely confined, ill ventilated place because he is a productive animal that usually works at 'top-speed'; especially is thus true when fattening, hence he needs an abundance of untainted oxygen for his bodily functions.

"**Sanitation**—To clean and disinfect a hog house thoroughly is often imperative; the building should be free from inaccessible cracks and openings to permit this. Smooth walls and floors without crevices are to be emphasized. Crevices harbor filth, which encourages disease; bacteria that cause hog cholera, contagious sore mouth, white scours, and other troubles; and parasites, such as lice, worms and mange. Masonry construction offers superior sanitary advantages. Freedom from dust is absolutely necessary for successful sanitation. Dust encourages pulmonary afflictions, manifested by coughing, wheezing, sneezing, general lassitude, and discomfiture. Dust predisposes to pneumonia, so often fatal. Dust is likely to further worm infection of the lungs and alimentary tract, an avoidable bugbear of swine husbandry. The regular removal of litter and manure is encouraged and made easy by roof doors, and gable windows in small hog houses. The more easily one can clean the house the more likely it is to be clean. Bear in mind that the hog is more liable than all other domestic animals to gather disease infection from unsanitary surroundings; he is so anatomically constructed that he always breathes, eats and drinks close to the ground, where infection abounds.

"**Safety and Comfort**—High doorsills frequently cause abortion. Rough, uneven floors cause much discomfort, particularly to the pregnant sow. Slippery floors result in many accidents. Narrow or low doorways, through which swine must squeeze or crawl, are objectionable. Fenders that save the lives of suckling pigs are quite indispensable.

"**Convenience**—House details may be arranged to lessen the time and labor required to care for the swine herd. What is considered as one man's convenience, however, may be an inconvenience for his neighbor. Yet the following suggestive features are all more or less valuable in hog house building:

"Roof doors in small houses and alleys in large houses for quick and easy feeding, removal of litter or manure, and handling of herd.

"Bins for storage of feeds.

"Doors and windows which open or close easily and quickly.

"Room for supplies and appliances, such as veterinary medicines and instruments, feed cooker, water heater, stove, sleeping cot, and so on.

"Abundant water supply for drinking and flushing.

"Ventilators, readily adjustable.

"Litter carriers for removing manure.

"Shade devices, handily managed.

"Attached runners, for quick moving of small houses.

"Dipping tank, in or near house.

"Troughs arranged so as to be filled and cleaned with dispatch without interference from hogs.

"Feeding floor, located in or near by the house.

"Breeding crate and ringing chute under cover and near at hand, for winter service especially.

"Tile drainage for flush water, which may be conserved by running into farm liquid manure tank.

"Minor equipment, such as hurdles, automatic waterers, self-feeders, barrel or other storage for slops, and other devices.

"**Serviceability**—To be useful every day in the year means that a house must be suitable for farrowing time, for summer shade, and for winter protection. It is economical at times to use the hog house to shelter sheep, especially ewes with lambs, calves, or other domestic animals, thus adding to all around serviceability. However, that is not usually advisable. The more continuous service one secures the less the daily cost for shelter; to obtain a maximum of housing at a minimum of expense is the economic and practical objective goal.

"**Sufficient Size to Shelter Advantageously**—The capacity should be consistent with the number, weight, and class of hogs to be housed in the various seasons. To avoid overcrowding, have plenty of floor and overhead space; ventilation and comfort is thus promoted.

"**Reasonably Low First Cost**—This should be consistent with the service rendered.

"**Minimum Cost of Maintenance**—This charge may be systematically compared in various types of construction by placing them on the basis of the cost per annum, per sow, per litter, or per hog in general. A maximum of service for a minimum of upkeep charges is the ideal to work toward.

"**Pleasing Appearance**—A satisfactory house harmonizes with its surroundings, it is neat in architectural design and sensible in construction. Well chosen paint lends much to its attractiveness. In general, to add to, rather than detract from, the appearance of the farmstead should be the builder's ambition.

Interest Coupons from a Live Investment

THE LOCATION OF THE HOG HOUSE

"The prospective site for the hog house should be carefully studied. Some of the more important considerations to be emphasized are:

"**Economy of Labor and Time in Management**—To save time and energy, feed, water and bedding should be near at hand. Locate so the house will fit in with the general scheme for doing farm chores. Unnecessary steps are profitably dispensed with.

"**Sufficient Drainage**—Rolling ground is unquestionably best for drainage, while low, level land is usually damp and unfit for swine. Sandy soils furnish a desirable base because water drains readily from them. Heavy clay or gumbo water-holding soils are to be avoided. Drain tile may often be used to advantage.

"**Sunny Exposure**—Select an open, well sunned space because the direct sunlight must reach all portions of the house. Avoid the heavy shade of trees and other buildings.

"**Southern Slope**—The southern slope is preferable because of its warmth, which means much to the successful raising of suckling pigs. Warmth, dryness and natural air drainage, all conducive to the best results with pigs, are promoted by the southern slope.

"**Protective Windbreaks**—The extreme cold winds in Iowa come from the northwest. The more efficient site, therefore, should be to the southeast of a good, substantial windbreak of hills, trees, buildings, fences, or their happy combination.

"**Nearness to Pasture and Summer Shade**—Convenient pasture and shade are both indispensable for economical pork production.

"**Suitable Elevation**—The high situation is apt to be bleak, cold, and difficult of approach; the low, damp and unhealthy. The happy medium of elevation is indispensable for the good of both man and beast.

"**Prevention of Odors Reaching Dwelling**—Inasmuch as somewhat unpleasant odors may possibly be carried to the farm dwelling, the piggery should be a reasonable distance therefrom, and preferably not in the direction from whence the prevailing winds come.

"**Lessened Risk from Disease Infection**—Locations in close proximity to public highways, railroads, and open waterways, unless free from possible infection, are to be avoided. The neighbor's herd may carry infection; and that source of danger should be considered. A reasonably complete isolation of the swine herd is advantageous."

WOOD SUPERIOR TO ALL MATERIALS FOR HOG-HOUSE CONSTRUCTION

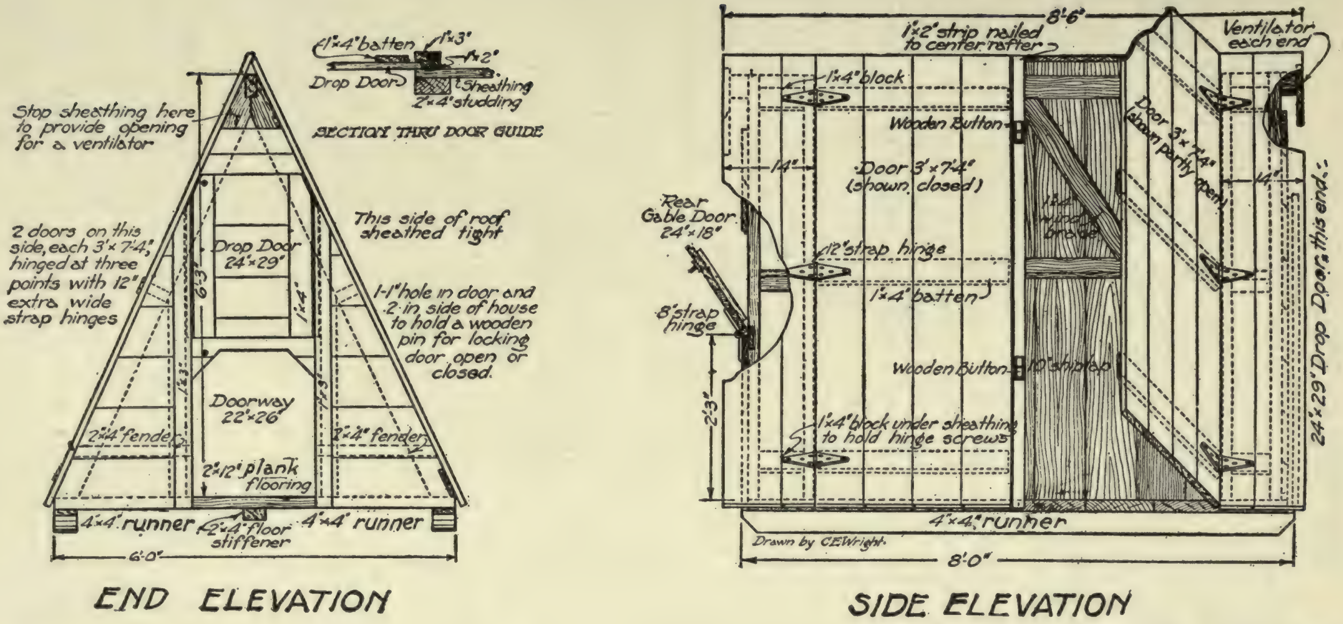
A good hog house should be warm in winter, cool in summer and not subject to great changes in temperature during the day and night. Buildings of wood meet these requirements as shown by an experiment made at the Iowa State College of Agriculture. An account of this experiment is given in the bulletin on "Movable Hog Houses" mentioned on page 5.

Four houses of the "A" type, two of wooden construction and two of sheet metal, were used in the test. One house of each kind had a floor area of about 6 feet by 8 feet, while that in the other two was about 5 feet by 7 feet. The object of the test was to place these houses out in actual use and find the relative warmth and amount of change in temperature inside during the day or night. They were placed in a row so as to allow the sun to shine directly upon the roof, sides and south end.

Each house contained three hogs of approximately 150 pounds average weight. These animals were kept in the houses for eight days with careful attention as to food and water. At the end of this time it was found that the three hogs in the large wooden house had gained 30 pounds, while those in the large metal one had gained only 26 pounds. In the smaller wooden house the three hogs had gained 25 pounds as compared with 20 pounds in the metal one.

The average range in temperatures in the wooden houses through a period of twenty-four hours was 21 degrees in the large one and 15.8 in the smaller. In the metal houses the corresponding average range was 36 degrees for the large one and 29.2 for the smaller. During this same period the temperature outside had an average range of 20.7 degrees.

The fact that the hogs in the wooden houses gained more in the same time than those in the metal ones, when all conditions were the same except for the lower range of temperature in the wooden houses, is a convincing proof of the superiority of wood in hog-house construction.


1"×4" batten
1"×3"
1"×2"
Drop Door
Sheathing
2"×4" studding
SECTION THRU DOOR GUIDE
Stop sheathing here to provide opening for a ventilator
2 doors on this side, each 3'×7'4", hinged at three points with 12" extra wide strap hinges
Drop Door 24"×29"
6'3"
1"×4"
1"×3"
This side of roof sheathed tight
1-1" hole in door and 2 in side of house to hold a wooden pin for locking door open or closed.
Doorway 22"×26"
2"×4" fender
2"×12" plank flooring
4"×4" runner
2"×4" floor stiffener
6'0"
8'6"
1"×2" strip nailed to center rafter
Ventilator each end
1"×4" block
Wooden Button
14"
Door 3'×7'4" (shown closed)
Door 3'×7'4" (shown partly open)
Rear Gable Door 24"×18"
1"×4" wind brace
12" strap hinge
1"×4" batten
8" strap hinge
10" shiplap
2'3"
1"×4" block under sheathing to hold hinge screws
24"×29" Drop Door, this end.
4"×4" runner
Drawn by C.E.Wright.
8'0"

END ELEVATION

SIDE ELEVATION

Redrawn from Bulletin No. 152, Agricultural Experiment Station, Iowa State College of Agriculture.

Fig. 1. The "A" Shape Portable House
Very simple in design and construction. Fenders needed only at ends. Doors may be hinged at top or sides as desired. A good, cheap type of house.

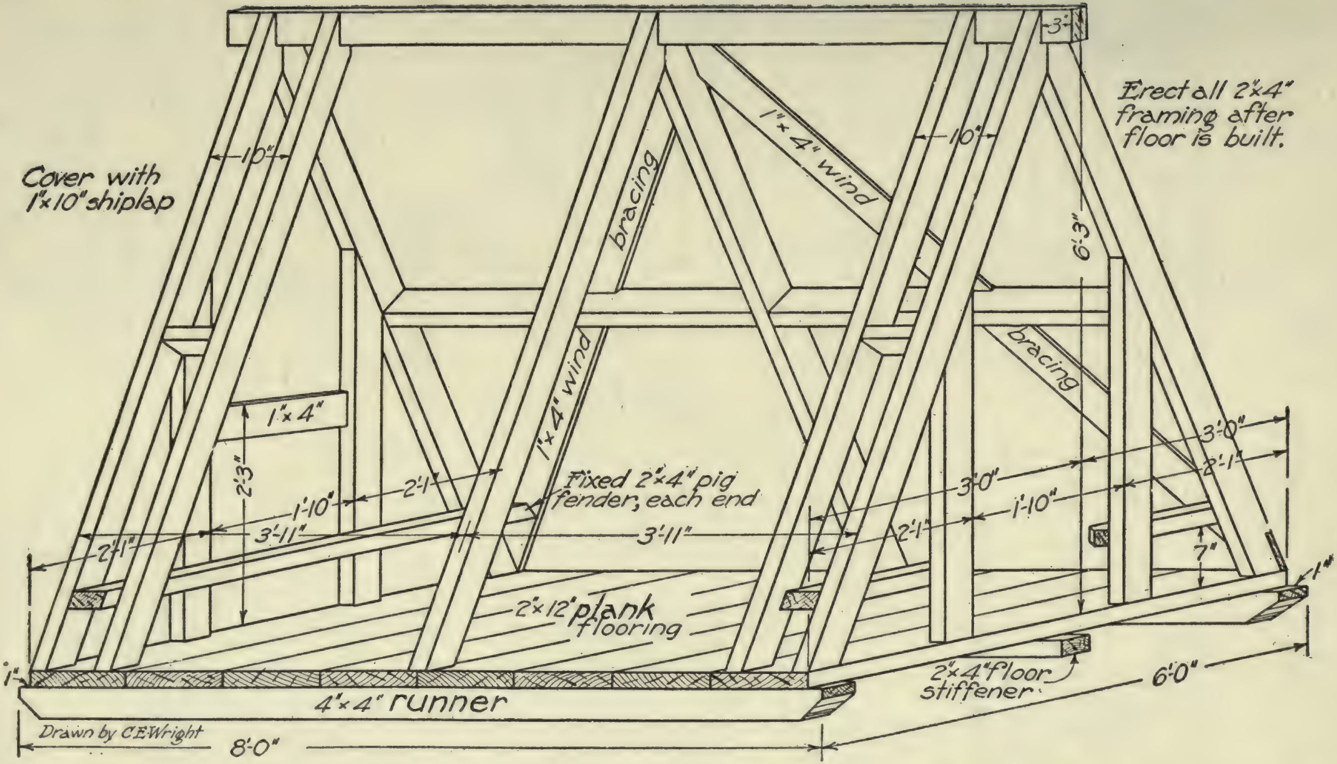
GENERAL FEATURES

Since the hog house, to be the most serviceable, should be used every day in the year, its construction should be rather substantial. On this account more money can be spent in construction than if the buildings were to be used only a few months during the year. They should be so planned that the largest amount of work may be performed with the least amount of labor, which in any business is an extremely important feature.

The framing is usually a combination of 2 x 4 stock and heavier. Of course, for small buildings the 2 x 4 material alone is suitable, but in the larger, permanent buildings heavier timber is necessary in order to make them substantial and durable. The walls are made close and warm. In the small portable building they may be of single thickness, but in the larger buildings they are usually made double, either by siding up both the inside and outside of the studs or by putting on a double outside layer with building paper between. Shiplap for the inner boards and drop-siding for the outer ones gives good results.

The question of floors is a very serious one which has worried hog raisers for many years. In a permanent building, the earth floor is decidedly unsanitary; so much so that its use can hardly be recommended. Brick and concrete have both been tried, but in many cases they have been so cold that it has been found impossible for young pigs to live upon them. Houses that have been so equipped have had to be changed and a wood floor provided. This is partly due to poor construction, for it has been found that if the floors are separated from the walls by a one-inch layer of asphalt or some such material the passage of cold is materially lessened.

Wood floors, if properly constructed and used, are reasonably durable and if made so that they are removable there is no reason why sanitation can not be practiced in the hog house without any great difficulty. Indeed, many hog raisers find that a movable wood floor to be used in the winter farrowing season is advisable. Creosoted flooring, or the creosote brush treatment of both floors and walls, is a sanitary measure and also adds to the durability of the wood.



FRAMING DETAILS

Redrawn from Bulletin No. 152, Agricultural Experiment Station, Iowa State College of Agriculture.

Fig. 2. Details of Framing for the "A" House.
Nothing heavier than 2x4 stuff is used except in the runners.

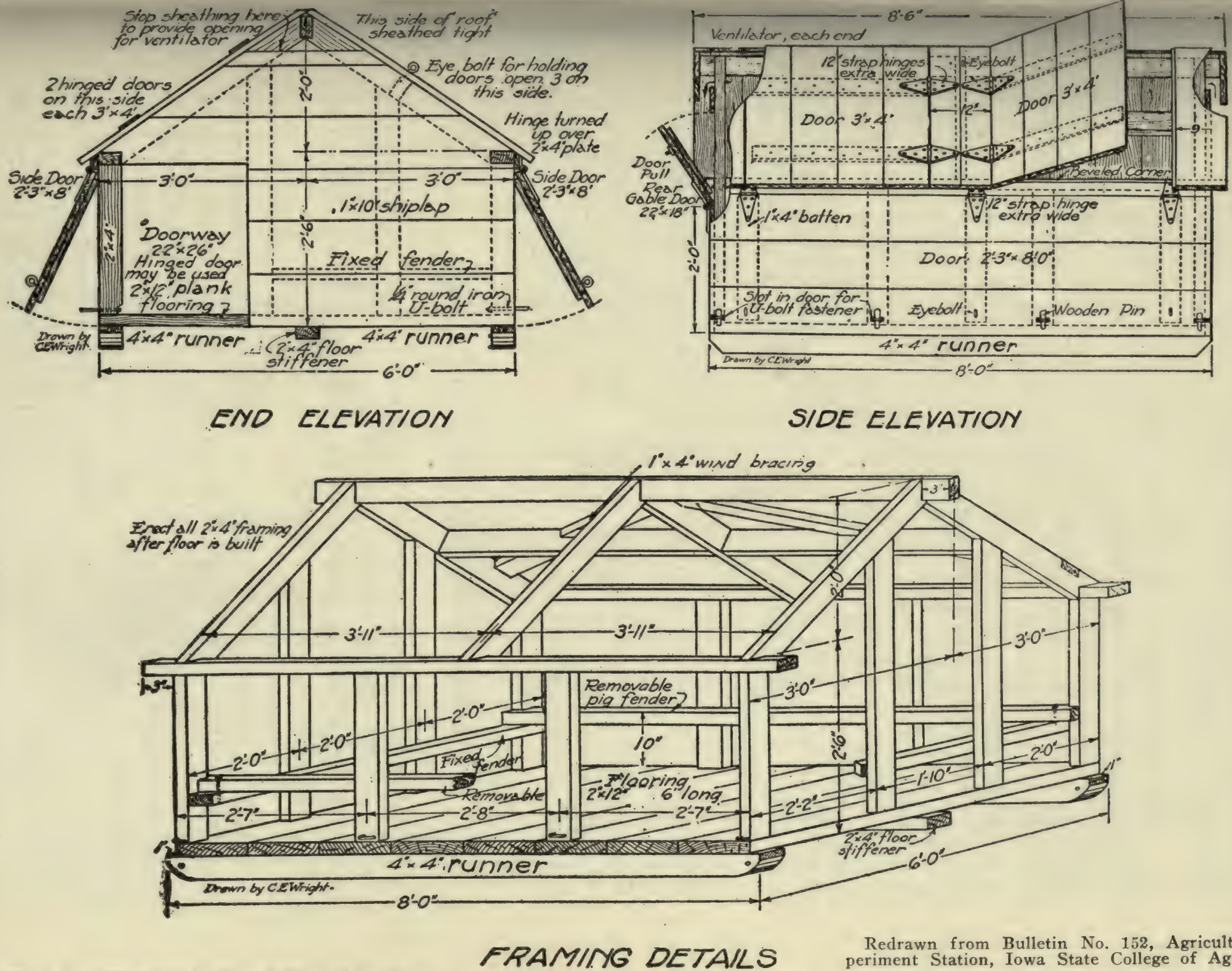
All hog houses must be provided with sufficient window space for light and sunshine. These windows should be inserted so that they can be easily and quickly opened and closed.

The interior of large, permanent hog houses may be arranged to suit the convenience of the owner. The partitions may be made permanent or removable. In this way the house may be used either with individual pens for farrowing, or in the late spring or fall the partitions can be removed to make it a feeding house. The individual owner will find many things which will suit his own convenience and wishes, and will use them to suit himself in his own hog house.

From an examination of the foregoing it is easily seen that the unit cost may become rather high in providing hog-raising equipment, and unless the farmer is careful the cost will do away with the greater part or all of the possible profits. It is very easy to put too much money into any farm building, and the hog house is no exception. No one can afford, for any purpose, a building so expensive that the interest and depreciation will more than equal its value as a shelter. Even for the farm on which hog raising is a highly specialized business it is doubtful whether it is advisable to make the cost per pen more than $50. In fact, half this amount can be made to give an exceedingly efficient building.

TYPES OF HOG HOUSES

Several types of hog houses have been constructed and used with varying degrees of success. Two general types stand out rather prominently, however, and are recommended by progressive hog raisers. These are the small individual portable type, and the large centralized stationary type with individual pens. The houses vary in design resulting from the needs and ideas of the individuals building them. The individual hog house, or cot, as it is sometimes called, has but one pen. This usually accommodates a sow and her litter. It has the special advantage of being readily moved, thus making sanitation easy. The renter who finds it impossible to provide expensive quarters for his hogs can well afford to build portable houses since they can be held as



Redrawn from Bulletin No. 152, Agricultural Experiment Station, Iowa State College of Agriculture.

Fig. 3. The Gable Roof Portable House
A little better and more expensive type than the "A" house. Admits of greater freedom in arrangement.

personal property. The individual house is quickly and cheaply built, easily moved and located wherever desired, is useful both to the general farmer and to the breeder of pure-breed stock, and only the simplest kind of workmanship is necessary to build it.

The large hog house is so arranged as to have a number of pens, each containing a sow and her litter. It is a comparatively durable building and possesses some advantageous points for the careful hog raiser. Excellent sanitation can be secured in a substantially built house of this type in spite of its size. The swine may be handled very easily and conveniently and the plan of the pens may be such that feeding can be done with very little labor. With removable partitions, the house may be divided into farrowing pens or the partitions may be omitted, thus providing for an abundance of light. In bad weather the feeding of hogs in a large, centralized house is much more convenient than when they are scattered about the lots in a number of smaller buildings.

It is possible that many farmers will find that their needs are best met by a combination of the centralized house and a few individual ones. The peculiar advantages and disadvantages which each may possess may be so equalized in the combination as to make the combined system a very efficient and practical one.

SMALL PORTABLE HOUSES

Figures 1, 2 and 3 show designs of small portable hog houses. The construction details are clearly indicated in these drawings so the average carpenter should have no difficulty whatever in using them.

In Fig. 1, the "A" shape, is a type of hog house that is perhaps more widely used than any other, since its construction is very simple. The framing consists of 2 x 4's mounted upon a 2-inch floor nailed to 4 x 4 runners. An end doorway is provided through which the swine may enter the house. On one of the sloping sides are set two doors which open to the side. These may be hinged at the top if desired, but it is better to have them hinged at the side, since with the latter arrangement a greater amount of sunlight

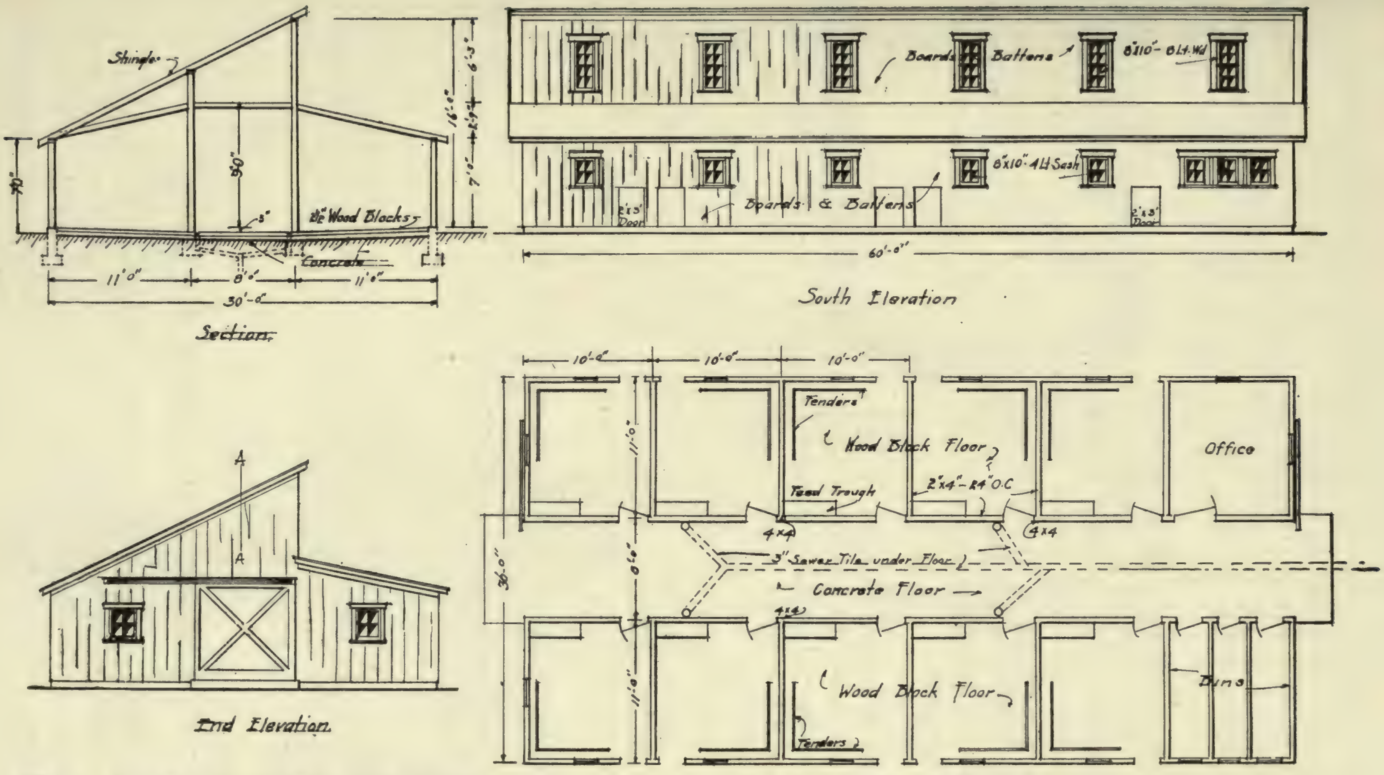


Fig. 4. A Large Rectangular Hog House.
The pens are shown rather large, but they can readily be reduced in size to suit average requirements. If desired, double windows can easily be put in. The width of driveway can be reduced if it is not necessary to drive through. Building should front to south.

may enter when the doors are open. One disadvantage of the "A" house is that there is but little choice in the selection of locations for the entrance door. It must necessarily be placed in the lower middle of the end. It is sometimes desirable to make the side doors double, that is, cut in two across the middle so that the lower portion can be closed.

Fig. 3 illustrates a portable house built with a gable roof. The framing is similar in some respects to that of the "A" frame house, in that it is all 2 x 4 stock mounted upon 4 x 4 runners. The important point in this particular type of house is that the straight walls enable the floor space to be used to better advantage. Arrangement for proper doors can be easily provided and the general appearance of the house is good.

The house may have doors at the ends and the sides and in the slope of the roof. Either the end or side doors can be used for the admission of the swine while all the doors may be opened in warm, sunny weather. In winter time, the end and side doors can be kept closed while, if desired, the roof doors can be opened, ordinary barn sash having been fitted in just below the doors inside the house. In this way, sunlight can be admitted without danger of drafts. The roof doors may be hung either at the side or at the top.

Fenders are, of course, necessary in any house which is used to shelter a sow and her pigs. In the small houses shown, the fenders consist of 2 x 4 pieces fastened flatwise 6 inches from the floor.

Both of the foregoing plans of small hog houses were taken from the excellent bulletin on "Movable Hog Houses" issued by the Iowa Agricultural Experiment Station, and referred to on page 5.

LARGE, PORTABLE HOUSES

In Figures 4 and 5 are shown complete drawings of a large, permanent hog house. This particular type which is known as the half-monitor roof type was developed by the Illinois Experiment Station. The drawings shown are based on the plans that were used in the construction of a

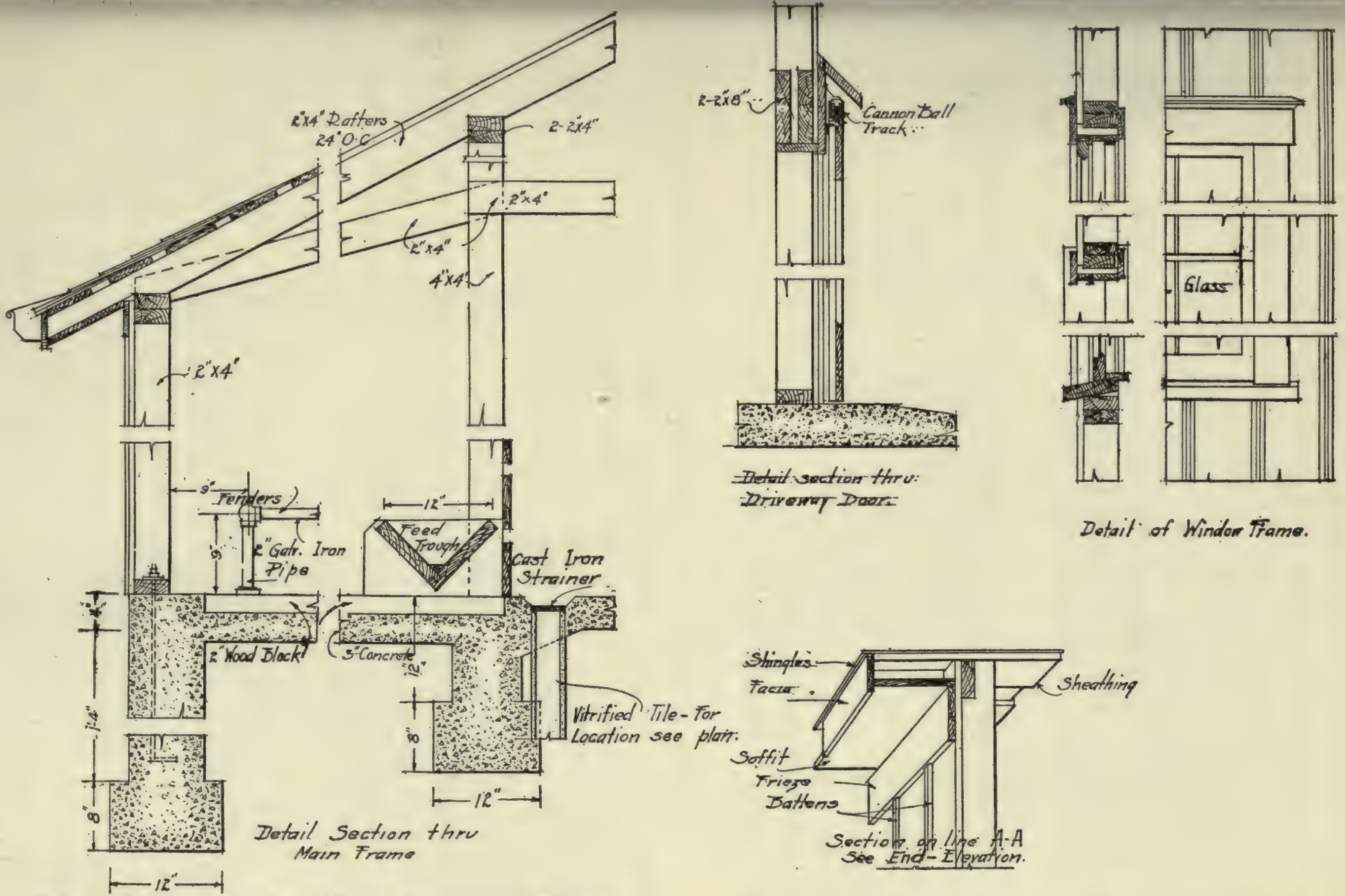


Fig. 5. Framing Details of Large Rectangular House.
Framing is practically all of 2 x 4 stock. Block flooring may be laid in asphalt to insure water-tightness. Finishing the cornice as shown adds to appearance of building.

large experimental hog house at that station. It will be noted that the pens are unusually large, perhaps larger than the average swine raiser would consider necessary or advisable. However, the house can be reduced in size and the pens made smaller. If the width of the house be made 24 feet instead of 30 feet, the length of the individual pens can be made 8 feet; the width can be made anything desired though 6 feet should be sufficient, not only in providing room for a sow and pigs, but in allowing ample space for a doorway and for a feeding trough along the driveway.

This type of house should be built with the windows facing the south. The illustration shows but one window for each pen; this number can well be doubled, for in cold weather or early spring plenty of heat and sunshine are needed. In order to make the house warmer, the outer walls can be made of double sheathing. For low cost, one layer of the wood may be omitted, but in case it is, a layer of building paper should take its place on the inside.

Numerous materials have been used for flooring hog houses, but none of them have proven so entirely satisfactory as wood. The ordinary plank floor is likely to be unsanitary, however, and for this reason it is recommended that where practicable it be replaced with a creosoted wood block floor as shown in the illustration. The floor of the central driveway is preferably made of concrete and provided with drain tile beneath the floor to carry the drainage from the pens. As will be noted, the floor of the pens slope to the edge of the central driveway where a shallow water drain is provided.

Fig. 6 shows the principles and details of construction of a highly practical form of large hog house. It has been used with excellent results in practice, and on several accounts is to be strongly recommended. The framing is extremely simple, and since the building is hexagonal in shape the different members of the framing are partly self-supporting. With the arrangement shown in the plan, it makes an excellent house for sheltering sows and pigs or for feeding shoats. The partitions between the pens are remov-

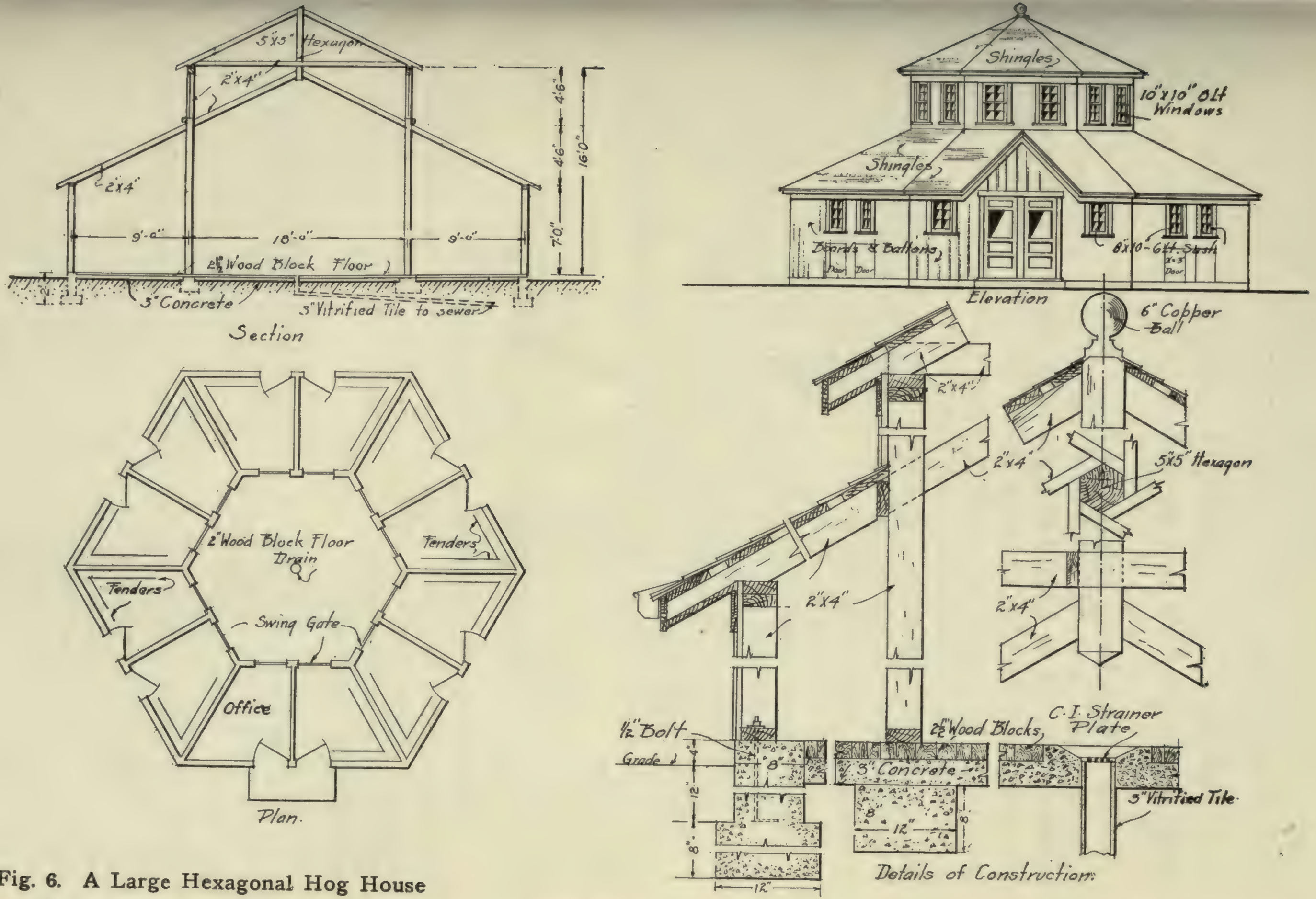


Fig. 6. A Large Hexagonal Hog House

Framing is very simple, with nothing heavier than 2x4 stock except the center pole. This house can be adapted to a variety of purposes, and is recommended as a good, all-round house for the average farm.

able, so that the entire house can be thrown into one large feeding area when desired. By clearing out as much of the interior work as possible, an excellent sale barn is provided. When the house is divided into pens, the central portion forms a place for the storage of feed.

The windows in the turret allow an abundance of sunlight for the pens on the north side of the building. The building should be located so that the main entrance doors are on either the east or west side. With this arrangement, the greatest amount of sunlight can be obtained through all the windows. The entire floor is constructed of wood blocks but if desired the central portion may be made of concrete. The floor slopes toward a central drain through which the drainage is carried away.

Nothing heavier than 2 x 4 stock is used in the construction of this shed with the exception of the portion of the center-pole, which is made from a piece of 6 x 6 stock. The entire roof is covered with wood shingles. The walls are sided with boards and battens, but if a more finished appearance is desired the shingles may be continued down the walls.

PARTITIONS AND DOORS

Where no set dimensions are demanded for location of partitions and the size of doors, the following suggestions from Farmers' Bulletin 438, U. S. Department of Agriculture, will be of service in the arrangement and design of a serviceable building:

"In making the inside partitions, care should always be taken to have them perfectly tight at the floor and for about 10 or 12 inches above, so that young pigs can not crawl through, and so sows in the adjoining pens can not get hold of them and pull them through. A sow will often pull a newly-born pig through under a partition and eat it, when, if the pig was in the pen with her, it would be perfectly safe. Above the first 10 or 12 inches it is better to have the partitions open enough so the hogs can see out, otherwise at every sound the sows will be up on the partitions to see what is going on.

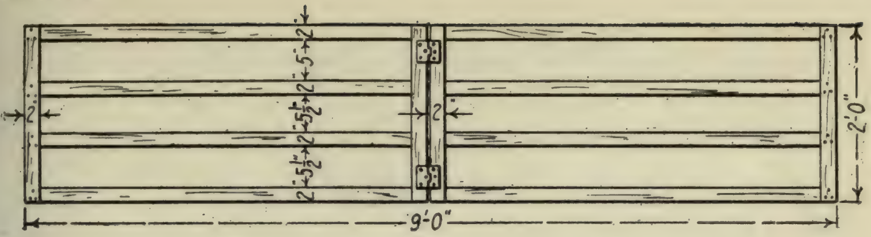


Fig. 7. A Convenient, Easily Carried Hurdle.

These may be made in single panel lengths, but the hinged hurdle is more useful in sorting and catching pigs.

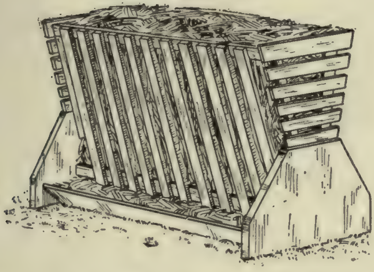


Fig. 8. A Roughage Feed Rack for Swine.

For feeding alfalfa, clover, soybean hay or other coarse feed, a rack of this kind is handy and prevents waste. More simple racks are often constructed on the inside of a hog house by placing them against one of the sides of the building or adjoined to the pen partition.

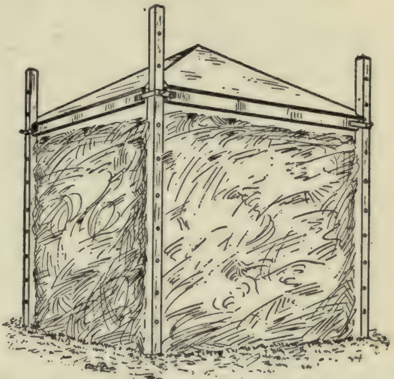


Fig. 9. An Adjustable Roughage Stack Cover.

Roughage, stacked in the hog lot where it can be easily thrown down for feeding sows in winter, should be protected by a cover. A simple roof adjustable on four corner posts is satisfactory.

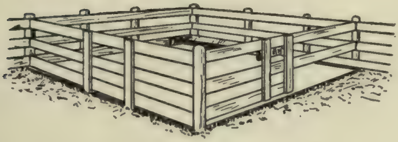


Fig. 10. Creep for Feeding Small Pigs.

Little pigs begin to eat grain at from three to four weeks of age, and should be provided with a small pen or enclosure where they can feed separately from the sows.

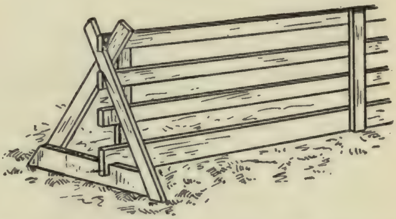


Fig. 11. Fencing In the Feed Lot.

The portable fence is made to enclose the portable house and for enclosing temporary quarters and lots. The panels are held erect by the supports which should be nailed to stakes driven into the ground.

(From Bulletin 242, Agricultural Experiment Station, University of Wisconsin.)

"Pig rails or guardrails should be placed on the inside of the pen, from 6 to 10 inches from the floor, according to the size of the sow, and should stand out 6 or 8 inches to prevent the sow from mashing the pigs against the wall.

"It will be found convenient to have the alley gates removable by lifting out. It is sometimes helpful, also, to have part or all of the partition fences removable. All partitions should be 30 to 36 inches high.

"Six by eight feet is generally found to be a very satisfactory size for pens, but if feeding is to be done inside, the pens will need to be longer in order to give room to feed and water without getting the bed befouled. Very large sows, such as are sometimes kept by breeders, may need more room, but the producer of pork will not need a larger pen. Small sows do not need this much room, and it might be good economy to make half of the pens 5 feet wide. Five by eight feet will accommodate a small sow very well.

"Hog doors should be 22 to 23 inches wide and 30 to 31 inches high in the clear. In cold weather a piece of burlap or ducking hung at the top of the hog door, with a stick a little shorter than the width of the door nailed across the bottom to prevent the wind from blowing it back, will help materially to keep the pigs warm. The pigs will soon learn to lift the curtain when they want to go through. The board doors in cots would not then need to be closed except in very bad weather, or while the pigs are very small."

THE NEBRASKA HOG HOUSE

The hog house shown in Fig. 12 is taken from drawings furnished by the Department of Agricultural Engineering, University of Nebraska, Lincoln, Nebraska. It is claimed that this house can be kept warm very easily because of the low ceiling. The window arrangement allows an abundance of light and provides for a maximum of sunlight on the floor.

A storage space for bedding or other material may be provided by placing a mow in the building. The mow floor will prevent a rapid escape of heat from the pens below.

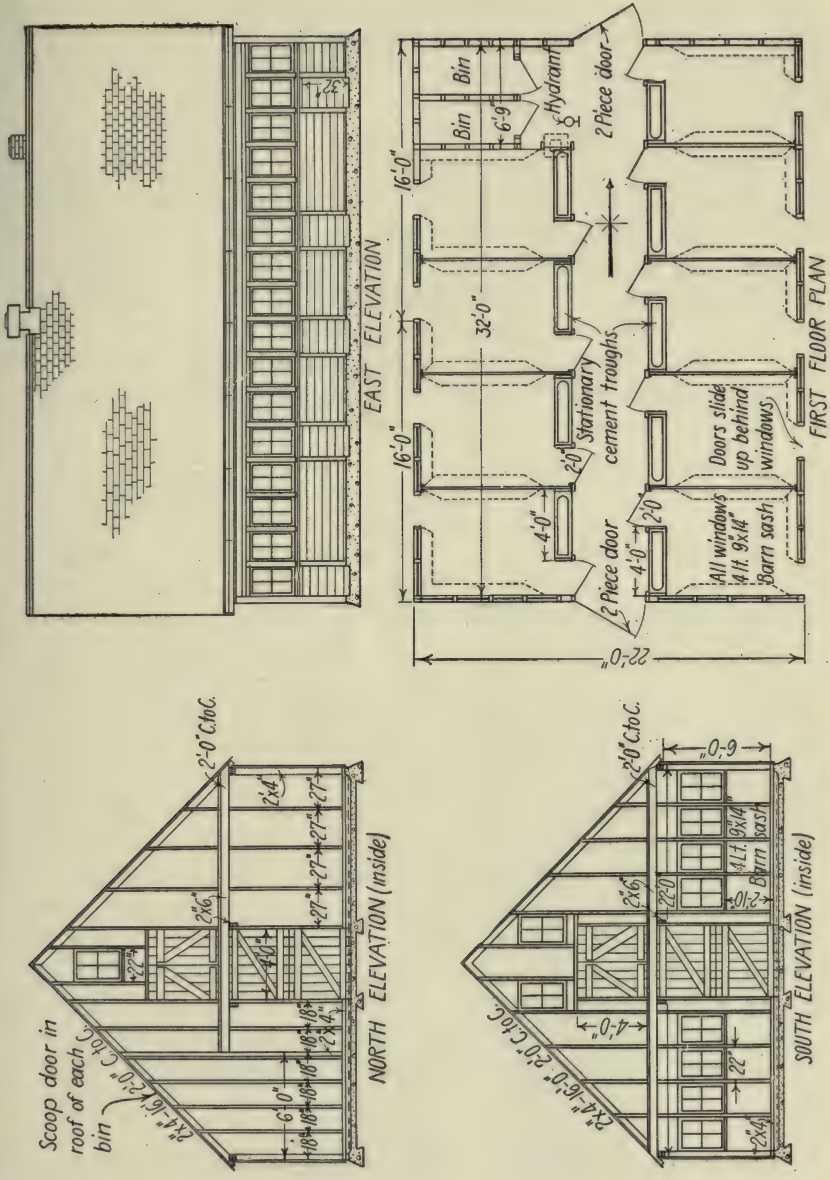


Fig. 12. The Nebraska Hog House.

A SERVICEABLE HOG HOUSE

The building shown in Figs. 13 and 14 is described in Farmers' Bulletin 438, issued by the U. S. Department of Agriculture. Extracts from that bulletin in reference to this hog house are as follows:

"Figures 13 and 14 represent a house built by one of the most prominent Duroc breeders after careful study. It is a most serviceable structure and one of the best the writer has ever seen. It is one of the few hog houses that have proved so satisfactory that the owners are willing to duplicate them. This house has been copied by a number of farmers in the vicinity, some of whom, however, have made the mistake of building a longer house and not making provision for outside pens for the extra inside pens.

"The walls are sheathed, papered, and sided. The roof is shingled. The outside floors on the east, west, and south are 6 feet wide. This house is 22 x 36 feet and contains ten pens. It was built north of Omaha in 1905 and cost, complete, including labor, $275, or $27.50 a pen. This includes the outside floor and pens.

"The gates across the alley all lift off their hinges so they can be removed or replaced in a moment. This arrangement makes it very convenient in sorting hogs to change them from one pen to another or to make extra pens when crowded. When swung across the alley the free ends of the gates fasten with common house-door bolts. By putting these on so the knobs turn up instead of down, the owner finds that hogs cannot open them. If the knobs turned down the hogs could open them readily. The fronts of the pens next the alley are all loose panels which lift out. In this way the whole house can be made into one large room in a few minutes, nothing but the pen partitions being left in place.

"The inside pens are 7 x 8 feet, except the middle one on each side, which is 8 x 8 feet. (The pens are irregular in width because the lumber cut this way to better advantage.) The hog doors are 22½ x 31 inches in the clear. The large doors are 3 x 6 feet, divided in the middle. The upper win-

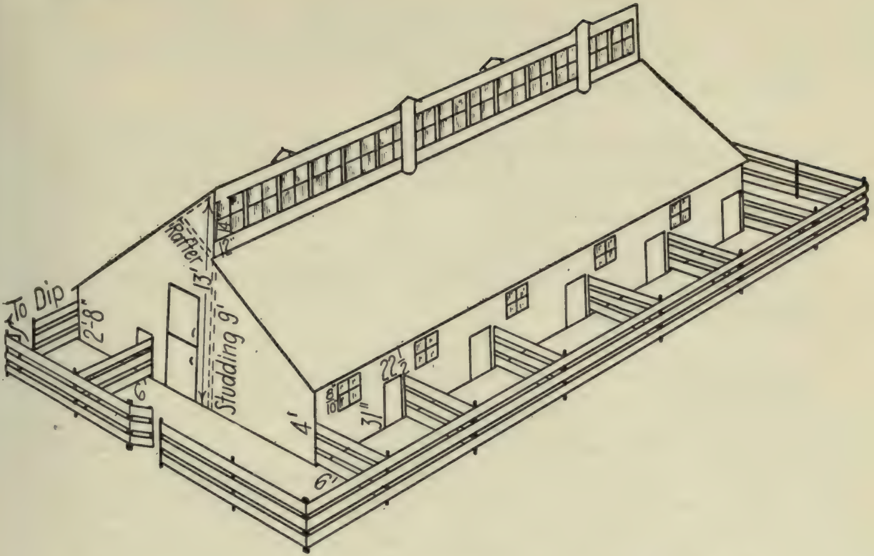


Fig. 13. General Construction and Arrangement of Outside Pens for a Serviceable Type of Hog House.

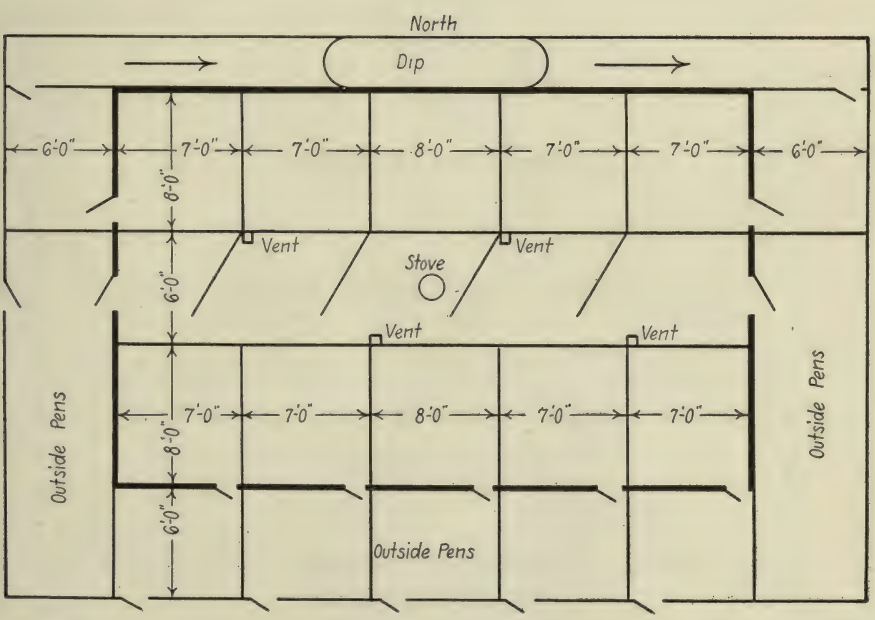


Fig. 14. Floor Plan of Building in Figure 13, Showing Arrangement of Inside and Outside Pens.

dows each contain four 12 x 14-inch lights and are set solid and close together. The lower windows each contain four 10 x 12-inch lights.

"The most striking feature of this house is the ingenious way in which outside pens have been provided without having them on the north side. There is an outside pen for every inside pen except one, the sows on the north side going out as indicated in Figure 14. This could not be accomplished with any more pens.

"The ventilators are 6 x 6 inches inside. The lower ends are 2 feet above the floor and the upper ends just above the comb of the roof. The south rafters are extended to meet the north rafters so that no studs are needed under the south edge of the north roof (See Fig. 13). Whether this gives any advantage is doubtful. The sunshine will strike the floor in all pens several hours a day on March 1.

"The dipping tank is convenient, but in a cold place. Perhaps this could be bettered."

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by

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JULY, 1916

General Series No. 38 Second Edition, December, 1916.

The Poultry Products of America are equal in value to one-half the entire corn crop of the nation.

The cost of producing poultry meat per pound is no more than that of producing beef or mutton. Proper housing reduces cost of production.

Poultry House Construction

By K. J. T. Ekblaw

If the farmers of this country realized more fully the great money-making possibilities of poultry raising when conducted with proper care and attention, they would be enriched by millions of dollars every year. Census figures indicate that the industry is practically on a par with the wheat crop, horticultural or dairy products.

The poultry products of America, despite the fact that the conducting of the poultry part of the average farm is a side line for the attention of the farmer's wife, are equal in value to half the entire corn crop of the nation. The cost of producing poultry meat per pound is no more than that of producing beef or mutton. Since this condition exists with the poultry industry in a more or less haphazard condition, the possibilities of systematic poultry farming are instantly evident.

Two needs are at once apparent, the necessity of having an adequately equipped and constructed poultry house, or houses, and that of expert care for the poultry on the farm.

It is well worth while for the farmer to give his personal attention to the problem, for the successful production of high grade poultry on an extensive scale is a man's work. The women on the farm who usually care for the poultry realize the value of it and know how well they are repaid

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Note: The drawings in this bulletin are by Walter Buehler, consulting engineer. He also assisted in revising the text and contributed the chapter on equipment.

for a comparatively small expenditure of time and labor. It is safe to assume that many farmers would find it profitable to reduce the amount of land they are cultivating and devote more time and attention to the poultry business, because with reasonable effort, the resulting profits will be surprisingly high.

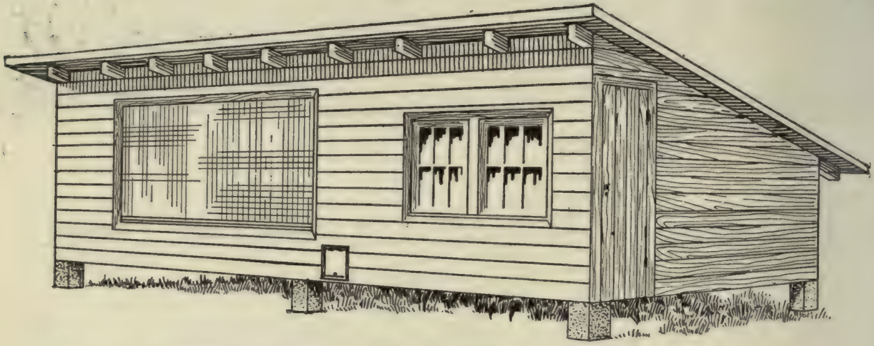


FIG. 1. TYPE OF HOUSE USED ON LINDEN HILLS FARM, OAKLANDON, IND.

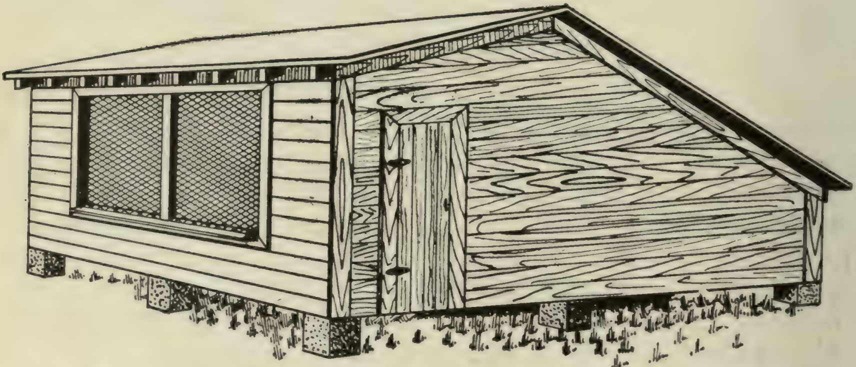


FIG. 2. TYPE OF HOUSE USED IN GOVERNMENT POULTRY FARM, BELTSVILLE, MD.

The housing of poultry is one of the most important subjects connected with poultry production, for not only the comfort, but the health and productiveness of the fowls depend on proper housing. A perfect house that fulfills all conditions with absolute satisfaction has not as yet been devised. Certain tendencies in design, however, are rather predominant, and successful growers are gradually coming to the adoption of more or less standardized forms of poultry houses.

Types of Buildings. The old-fashioned closed-type house is a thing of the past. It has been very clearly and definitely determined that the open-front type, as it is called, is the type of the future and this style of house, in a more or less modified form, is to be found in all parts of the country. The open-front idea can be applied to houses in which various construction features are incorporated. The colony house, the brooder house, and the permanent house all can have the open front to advantage.

The open-front house is tightly enclosed on all sides except the south, which should be the front, and this should be partly or completely open to the outside air. This gives free ventilation without drafts. If cold, damp winds are likely to gain access to the house through these openings they may be protected by a muslin or cheese cloth shield to break the force of the wind and yet admit the air freely so that circulation is not stopped.

Two general systems of poultry raising are employed, one the intensive type, in which a great number of fowls are forced to rapid development in large houses, and the other the extensive system, in which small buildings and a large range are part of the essential features. The first system means a rather heavy investment per bird and depends upon quick production and rapid development for profits. The second system has a much lower investment per head, and consequently, is not so dependent upon ideal results.

For the average farm, the intensive system is not to be considered, because a great deal of skill is required in the handling of the poultry, the investment is high, the risk is great, and the probability of loss is by no means small. The successful poultry plant of the future will probably maintain the colony system for rearing young stock for breeding and show purposes, have a large winter laying house for economic and profitable egg production, and a brooder house for specialties and for out-of-season rearing.

Location. The first thing that must be borne in mind in the design of any house which is to shelter poultry, or any animals, is the location. Drainage should be given precedence, perhaps, to convenience, for no matter how conven-

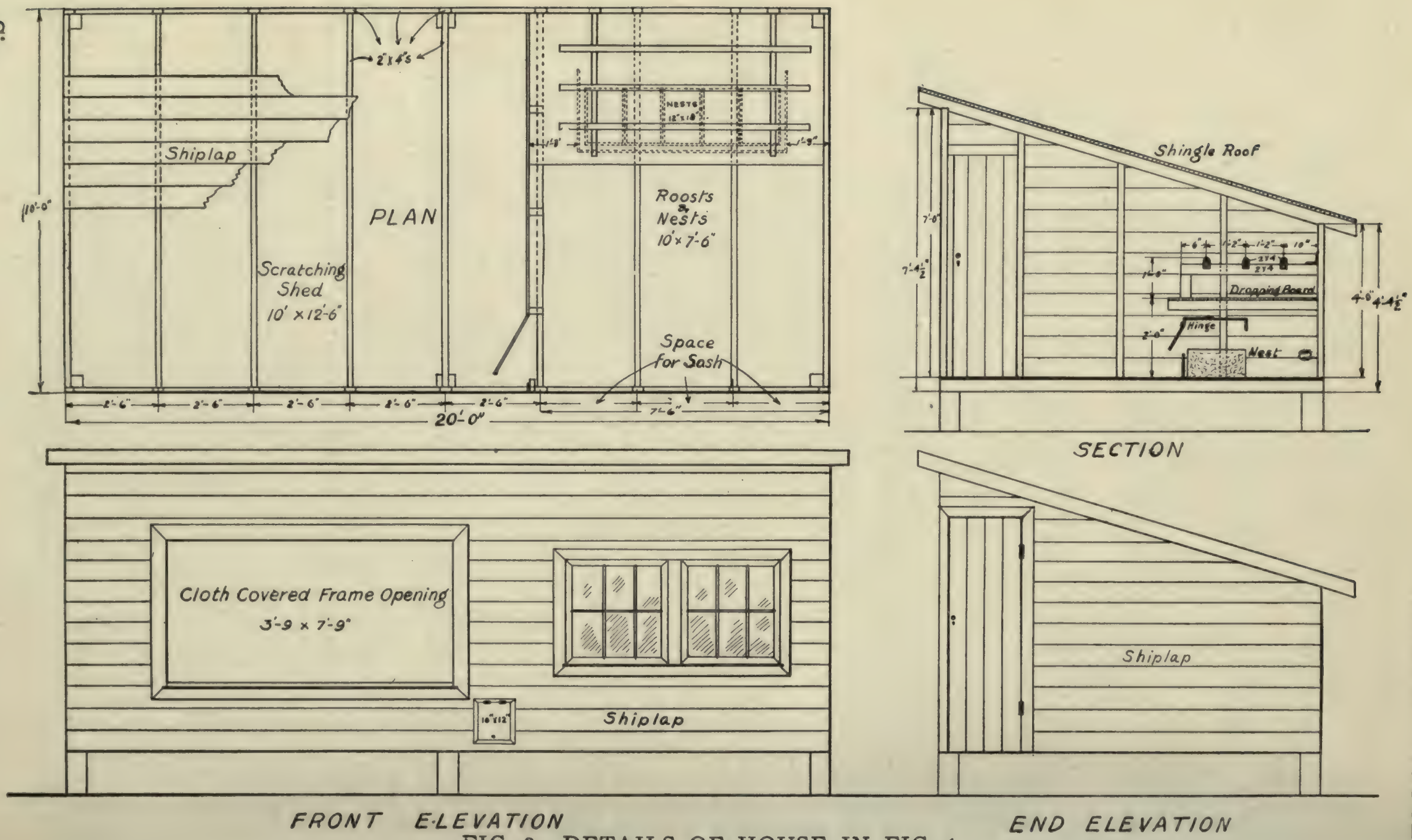


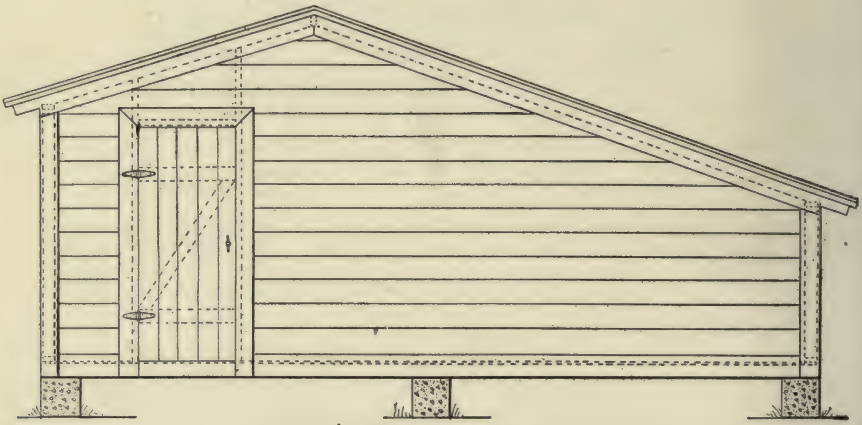
FIG. 3. DETAILS OF HOUSE IN FIG. 1.

iently located a house may be, if the drainage of the site is poor, so that the health of the fowls suffers, the only result will be failure. Since it will undoubtedly be true that the women of the household will have considerable to do with the management of the poultry, it is logical to place the poultry house nearer to the residence than to the livestock barns.

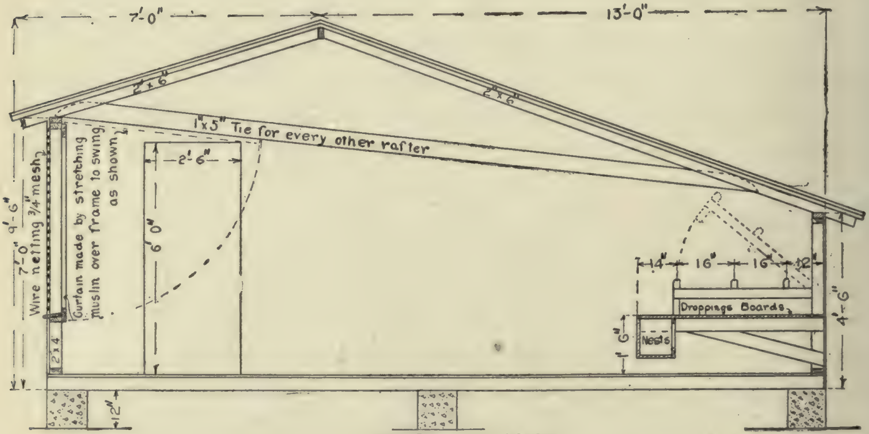
Drainage and Ventilation. No condition is more productive of disease than dampness, and it is quickly fatal to fertility and production. If the ground has a gentle slope, preferably to the south, and if the soil is loose and porous, no fears need be felt in this regard. If the site is not dry it should be made so, either by filling or by putting in drains.

Fowls are peculiarly susceptible to the ill effects of bad air, consequently, it has been found necessary to include in every poultry house some means of providing a ventilating system which will furnish an adequate supply of fresh air. This air must be supplied in such a way that no drafts will be produced. It has been estimated that 200 five-pound hens, while weighing the same as a horse or cow, will breathe from 2½ to 3 times as much air in the same length of time. One reason for this is the high body temperature of poultry, which will average 106 degrees Fahr. Another reason why ventilation is necessary is due to the well known fact that any poisonous principle is more poisonous to another individual who is compelled to breathe it than to the individual who expired it. It is easily seen how serious this is where a hundred or two hundred individuals are crowded together in a comparatively small space. The open front, or curtain front, is the means which is usually adopted to obtain ventilation. Sometimes a further supply of fresh air is provided by making openings in the gable ends of the house. A layer of straw inserted near the ceiling will admit the passage of air through it, but will break drafts up so that they do not come directly upon the fowls.

Sunlight and Sanitation. Sanitation, the keynote of modern building construction, applies with remarkable pertinence to poultry houses. One of the greatest germicides known is sunlight, and, since fowls are crowded into the house in the winter time, it is absolutely necessary that the maximum amount of sunlight be supplied to them. Not only is the sunlight an efficient aid in the destruction of disease germs, but the heat that is carried in with the sun's rays in winter will produce conditions conducive to the maximum egg production. In consequence of this it will be found advisable, in all poultry houses, to so build them that the full amount of sunlight available is utilized. A certain amount of the light will, of course, come

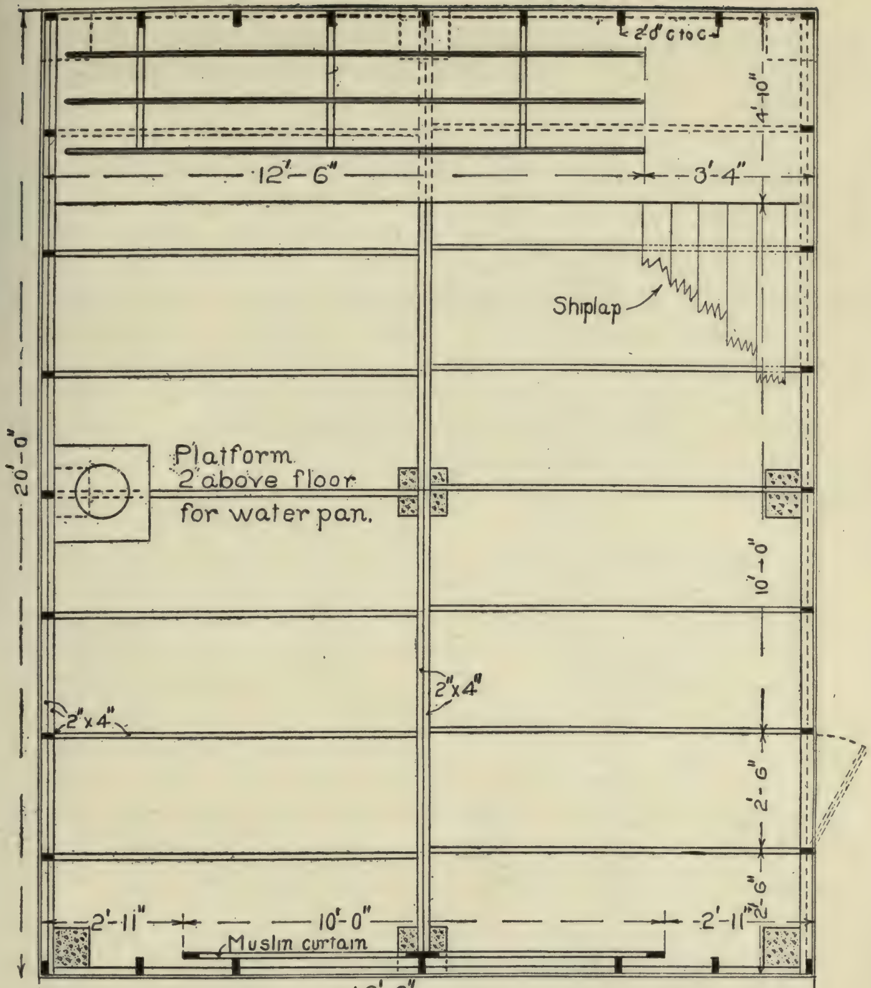


SIDE ELEVATION

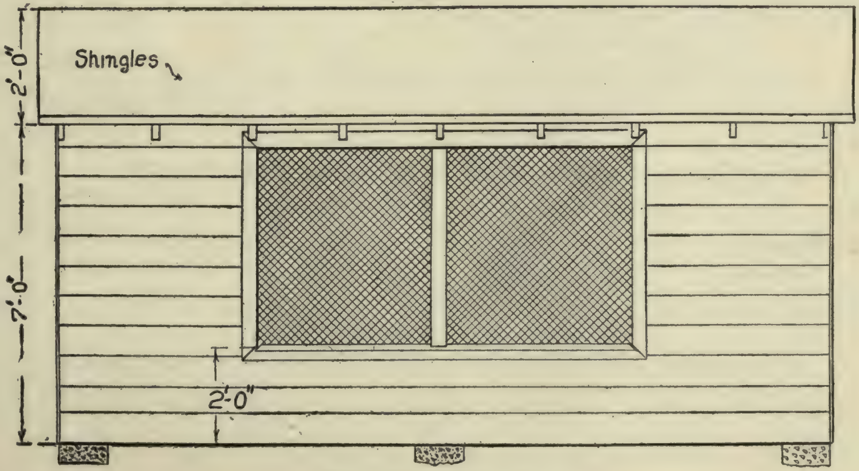


CROSS SECTION

FIG. 4. DETAILS OF HOUSE IN FIG. 2.



PLAN



FRONT ELEVATION

FIG. 5. DETAILS OF HOUSE IN FIG. 2.

in through the muslin curtained openings, but some glazed openings should be provided through which the sunlight may come in directly.

In addition to the sanitation which can be accomplished by the use of sunlight, there should also be provided a dry dust bath, which will aid in eliminating lice. Other means for maintaining the welfare of the fowls may also be employed, such as making provision for easy disinfection in case some one or few of the fowls become affected with a contagious disease. The floor, if of earth, should be spaded up occasionally and mixed with lime, which in itself is a germicide. The interior of the house should be sprayed with a disinfectant or white-wash, in order to discourage the multiplication of germs and vermin.

Construction. From 2 to 5 sq. ft. of floor space should be allowed for each bird. Fresh air should be provided by ventilation rather than by increasing the size of the house. Ventilation can be secured by means of a few openings under the roof, at the back of the house, which should be filled with straw, so as to prevent drafts. The floor space is dependent upon the breed of birds housed, and the system. Less space is required for birds under the colony system, where they have free range, than with the intensive system, where they have small fenced-in-areas. The small breeds, such as Leghorns, require less space than the larger breeds, such as Brahmas.

The large colony house should be set on concrete or wooden posts or concrete walls. If wooden posts are used they should be painted with a good preservative.

Where good drainage is available, dirt or gravel floors are satisfactory. In general, however, a tight board floor, well oiled with an ordinary floor oil to keep down the dust, and well littered with straw, is the most satisfactory. The floor should be raised off the ground a sufficient height to enable dogs or cats to get underneath, so as to prevent the harboring of rats, and also to allow free circulation of air, to prevent the rotting of the floor.

The back and two ends should be tight so as to insure against drafts. The front depends on the type of house.

Too much glass should not be used, as it radiates heat very rapidly, and while warm in day time, is cold at night. Light weight muslin or duck, tacked on frames, makes a very satisfactory covering for the openings in the front of the house, as it will permit of free circulation of air without drafts. The front should be sufficiently high to allow sunlight to reach well back into the house during winter.

The roof is a most important part of the house. It must be watertight. Shingle roofs are the most satisfactory, as they are cooler in summer and warmer in winter than those constructed with metal or prepared roofing. There are several types of roofs. For small houses the shed type is the best. It is the easiest to construct, and it allows a high front to the house. The combination type, as in Fig. 2, is adapted for houses over 16 feet and up to 24 feet wide. It is a very

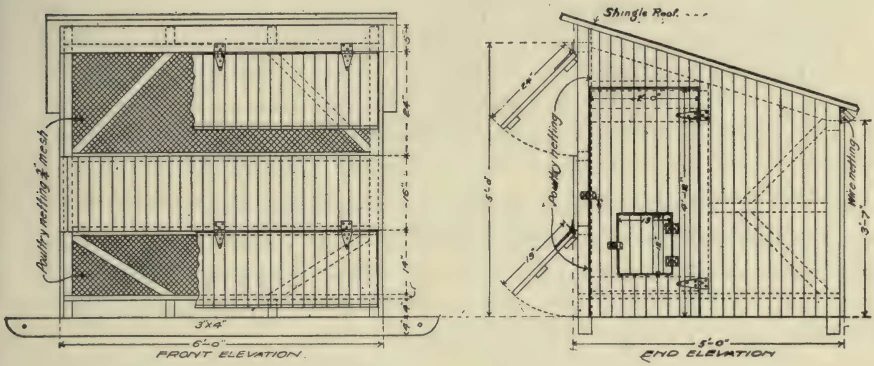


FIG. 6. SMALL PORTABLE COLONY HOUSE.

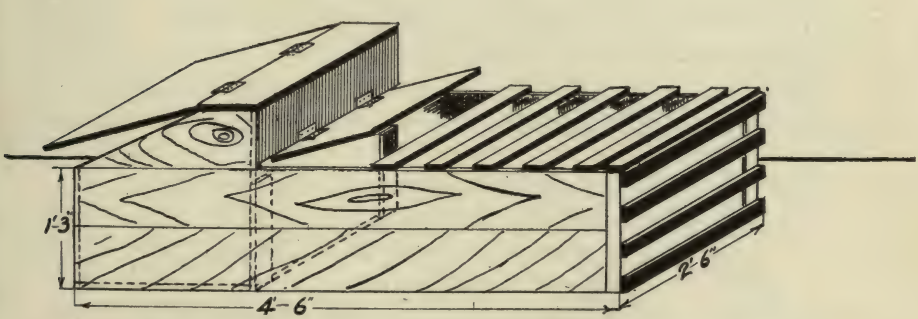


FIG. 7. COOP FOR SETTING HEN AND CHICKS.

satisfactory roof for the type of house shown in Fig. 2, as it gives the best head room for the least cost, and reduces the amount of surplus air space.

In type of house shown in Fig. 3, the roosts, dropping boards and nests are placed in the back of one end of the house, separated from the other end by a tight partition. Roosts should be hinged, and placed level. Nests can be placed under dropping boards. In type of house shown in Fig. 2, roosts, dropping boards and nests are placed in the back of house, and protected during severe winter by a muslin or duck curtain which drops from the roof to within about one foot of the floor.

Any durable lumber available can be used for the construction of the house. The outside should be well seasoned to prevent excessive shrinking. Shiplap is very satisfactory for floors and sides of houses, as it can be laid up quickly and makes a tight floor or side. For floor joists and studding 2 x 4's can be used. For roof rafters, 2 x 4's or 2 x 6's can be used, depending on the type of house.

Painting adds both to appearance and service. Ready mixed paints can be purchased. On new lumber a priming coat, made of equal parts of paint and linseed oil, should be used, and then covered by one or two coats of paint. Whitewashing the interior of the house adds to its appearance, and is a great assistance in keeping the house clean and fresh. An excellent whitewash disinfectant can be made as follows:

Mix: 1 peck unslacked lime,
2 lbs. common coarse salt,
1 gal. crude carbolic acid—dilute to
40 gals. with water.

Equipment. An important feature of the poultry business, sometimes overlooked, is the equipment of the houses. Proper equipment makes daily work much easier, especially in tending a large flock. A fair outfit of tools is very essential. The total cost of such an outfit is not very much, and its value can hardly be estimated. All equipment should be simple. Portable equipment is the best, as it and the space occupied can be more easily kept clean. The principal equipment consists of receptacles for food and water, nests and roosts. Food receptacles consist of wet and dry mash hoppers, grit, shell, and charcoal hoppers.

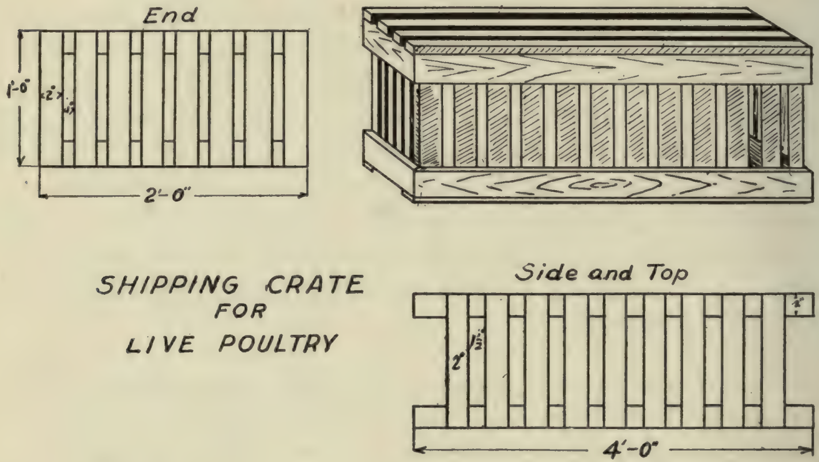
The "V" shape trough, made of 6 or 8 in. boards, any length, is best for wet mash. Dry mash hoppers must be made so they will not clog. For small flocks a small box 6 or 8 in. deep, with lath nailed across the top so as to prevent the birds scratching in the mash, will be found satisfactory. An ordinary stove pipe, about 2 ft. long, suspended above the top of the box with bottom about 4 in. from bottom of box, will increase the capacity of hopper. Figure 8 illustrates a simple and effective grit and shell hopper. All food and water receptacles should be placed on a platform about 18 in. above the floor, or hung on a wall with a conveniently placed platform for the birds to stand on. Grain and mash storage hoppers in each house, similar to illustration, Fig. 8, page 14, materially reduce the labor, especially in a colony system.

Nests are of two types; the simple open nest, and the trap nest. Both types are preferably placed under dropping boards, so arranged that the birds will be required to walk in under the dropping board and get into the nest from the rear, the nest being made accessible to the attendant by a hinged door in front. The trap nest is sometimes desirable for the development of exhibition birds, but is not absolutely necessary. Where large flocks are cared for there is entirely too much labor attached to the trap nest. Proper breeding can be accomplished by selection from the flock of small pens. One of the most successful breeders of White Plymouth Rock chickens in the country has developed his flock in this way.

Roosts should be of 2 x 3's or 2 x 4's, set on edge with the top rounded and set-in cross-pieces hinged to wall as per Fig. 4. The distance between roosts varies with the breed of bird. For Langshans and Brahmas, 10 inches; for Wyandottes and Plymouth Rocks, 8 inches; and for Leghorns and Minorcas, 7 inches, are proper. Roosts should invariably be located where they are out of the way of the attendant and not in a draft. They should be placed level. The ladder form of roost is very undesirable.

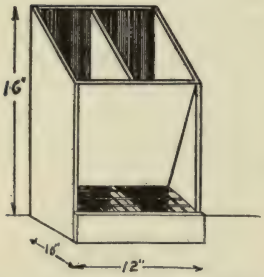
Simple coops for setting hens and taking care of chicks materially reduce the care and labor. Such a coop is illustrated in Fig. 7.

Yarding. As perfect sanitation is one of the prerequisites of success in poultry raising, the larger the yards the easier it will be to maintain healthful conditions among the flocks. The amount of yard space per fowl has not been definitely fixed, though a minimum of 100 square feet per fowl should be used, and 50 per cent, or even 100 per cent more than this is highly advisable. Under ordinary conditions, 150 square feet per fowl will probably be found to suffice. On the average farm, where the poultry is allowed free run of the barnyard and of the fields immediately surrounding

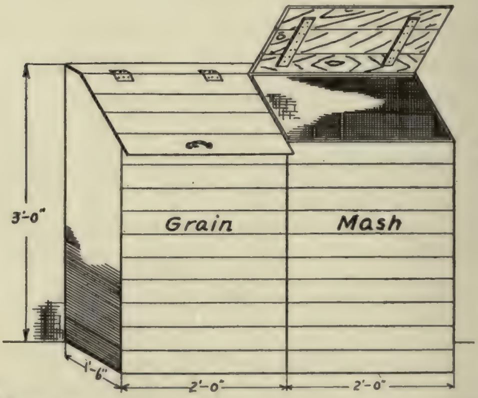


SHIPPING CRATE
FOR
LIVE POULTRY

FIG. 8.



GRIT AND SHELL FEEDER.



GRAIN AND MASH STORAGE HOPPER.

the farmstead, there need be no special attention paid to this particular feature, but the figures given above will be of some value as a guide when it is desirable to keep the chickens within an enclosure.

Considerable difficulty will be found in keeping the yards filled with green forage, which is excellent for the welfare of the fowls, unless the chickens are confined for a time, or the house and yards be vacated. If the yards be made double the arrangement will be more satisfactory, since they can then be used alternately during the season, with the chickens foraging on one yard while a fresh crop is being started in the other, thus using a pen continuously, or the yard may be used in alternate years. Of course, with a portable colony house which can be moved about, the necessity of yarding young chickens is greatly relieved. Such places as the farm lane, the orchard or mown meadow may be utilized to furnish fresh soil, sunlight and shade and an abundance of insects and other food conducive to the healthful condition and rapid growth of the fowls.

Poultry keeping offers opportunities for both pleasure and gain to both sexes, all ages, all walks in life, and in all sections of the rountry. It may be made a profitable pleasure alike in the country and in the city. It may be carried on as an exclusive business, or a side line; it can be profitably enjoyed by the poor and rich alike. As an exclusive business it should be carried on in the country; as a side line it may be conducted on a small area of land afforded by a city or suburban home lot.

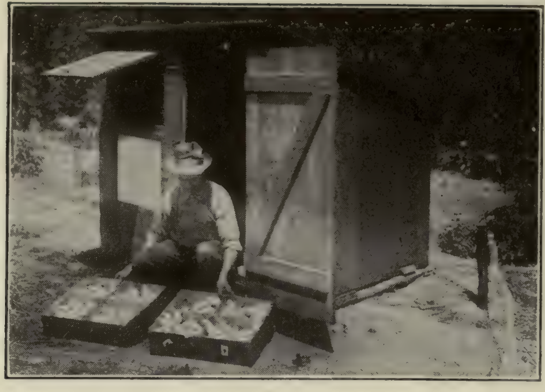


FIG. 9. A SMALL SHIPMENT OF BABY CHICKS.

Two boxes of baby chicks just as received from the express company. The covers are off ready to transfer the chicks to the hover in the portable colony house in the background.

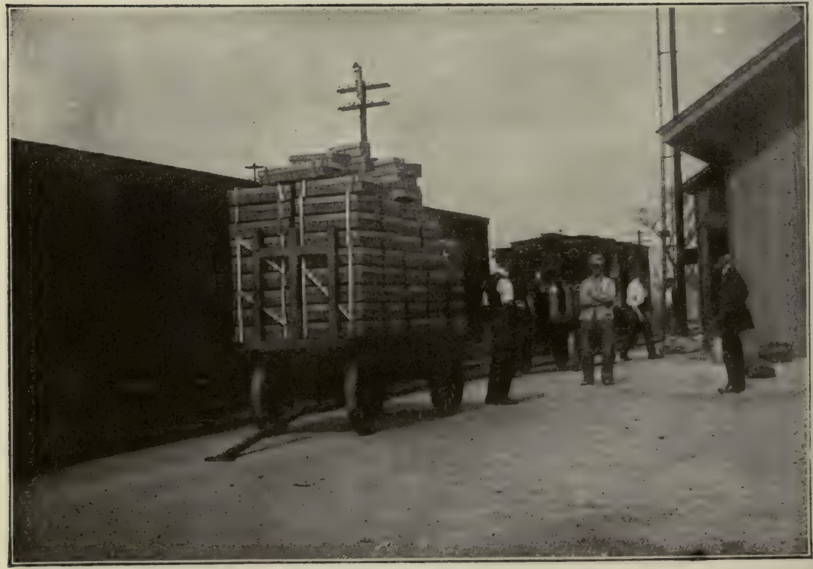


FIG. 10. ONE DAY'S SHIPMENT OF ABOUT 9,000 CHICKS FROM ONE HATCHERY.

Buying Baby Chicks

By H. D. WHITE,

Secretary, International Baby Chick Association.

There are certain outstanding advantages for the average poultry keeper in buying baby chicks. Many who are engaged in the poultry business, exclusively or as a sideline, are handicapped in keeping all the poultry they could properly and profitably care for by the problem of renewing their flocks annually. It is a question of quantity and quality alike.

Hatching under hens is out of the question except in special cases and with small breeders, and there are certain limitations even then. Setting hens need careful watching to obtain the best results and frequently the returns are exceedingly disappointing.

Incubators of all sorts, sizes and prices are obtainable and apparently simple in operation. But so much depends upon local conditions and the ability of the operator to use and understand them that artificial hatching still must be classed as a special "art," requiring an experienced hand properly to turn the trick.

With hens and with incubators there is always the uncertainty of getting a good sized hatch of strong husky chicks that will develop to profitable maturity. Both require the time of the poultry keeper just at the season of the year when everything else is pressing. Buying baby chicks, however, does away with all this. It eliminates the question of "where'll I find a broody hen to set" on the eggs just at the right time. Break up the broody hens and make them go on producing more eggs. It eliminates the necessary investment in hatching equipment that is used less than one-third of the year.

Buying baby chicks practically insures the certainty of supply. There is no worry over hatching results. It is possible to buy just as few or just as many chicks as are desired at one time. This means an equal chance for each chick to develop normally, and the even maturity of the whole flock. No inconvenience and annoyance of a lot of chicks of different ages, trying the patience and taxing the ability of the caretaker to minimize the customary attending drawbacks.

Agricultural experts and county agents in many states are advising those who start in the poultry business to buy baby chicks from reliable sources, because it affords the most practical way to establish a flock—strong chicks in full number, minimum initial investment, and economy of time and energy.

Responsible baby chick men quote very reasonable prices on chicks from various grades and breeds of poultry in keeping with the quality of stock, and guarantee satisfactory delivery to the customer. The shipping of baby chicks is made possible by the fact that the egg yolk which is absorbed into the chick's body just before it breaks the shell is sufficient to last the chick as food for at least 72 hours. In fact, harm results in feeding during that period. Shipment can be safely made to any point reached in that length of time. Express service is the only means of transportation at present, and the express companies make special provision for handling chick shipments. The parcel post has made no provision for handling live stock of any kind as yet.

In filling chick orders none but husky, vigorous chicks are sent out. Any cripples, weaklings or "sports" are culled. Specially designed boxes are used which protect the chicks from ordinary exposure, the natural body heat of the chicks keeping them warm while on the road.

The baby chick industry is not new. It is not an experiment, but an established business growing in proportions and in popularity. More than 20,000,000 chicks were shipped during 1916, ranging from 25 chicks to several thousand in a single order. There are no more dangers connected with the shipment of chicks than with eggs for hatching. Any injury to chicks received in transit are usually noticeable immediately and adjustments readily made. Eggs roughly handled in shipment may not show the results of their injury for two or three weeks.

CONSTRUCTION

Proper preparation for the chicks before arrival is important. There are numerous systems of brooding in practice and as many devices on the market to fit these systems. The important thing in the matter of preparedness is to see that suitable quarters are ready and warm for the chicks when they come. Express agents should be warned when chicks are expected so that there may be no delay in getting them into comfortable quarters.

Well-built, small, portable colony houses ranging in size from 5x6 feet to 8x10 feet, and sometimes larger, are best suited to average conditions. One type of such a house is shown in Figure 6. A coal-burning brooder stove or portable lamp-heated hover can be used in the house as long as the chicks need heat. It is then taken out leaving the chicks in the house until they are removed to permanent winter quarters. A small portable house is readily moved about to the orchard, the corn field or the shady lane, affording fresh new range ground for the chicks as often as desired. If properly constructed these houses can be quickly converted into practical laying or breeding houses by the use of simple portable equipment—nests, roosts and feed hoppers.

Further information on the baby chick industry and references to reliable sources of supply will be furnished by The International Baby Chick Association, Saugatuck, Mich.

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NOVEMBER, 1916

General Series No. 48

In regions where natural ice is obtainable the cost of storing, including hauling and packing, averages about $1 a ton. At this low cost no northern farm can afford to be without a good ice house and a summer ice supply for household and dairy use.

Ice Houses and Ice Supply

By F. M. White and C. I. Griffith

A supply of ice will help lower the cost of living. It is of greater economic importance to the farm home than it is to the city home, and not as expensive as might be expected. On some farms the loss of fruits, vegetables and dairy products every year would almost build an ice house.

Once accustomed to the use of ice, it becomes a convenience that is seldom dispensed with. With an ice supply it is possible to keep butter, eggs, meats, vegetables and fruits in a first class condition for the table as well as for market. Considering these advantages, a supply of ice will soon pay for itself. In most northern localities ice is free for the harvesting. The harvest season comes at the time of the year when men and teams have very little to do; therefore, the expense of putting it up is practically nothing. The ice house costs from $75 to $250, depending upon the size and type of structure.

The ice should be taken only from pure water. Lakes and rivers usually furnish it. They need practically no attention until the time of harvesting. Where there is no such supply, water from springs or streams may be stored by building a dam and flooding the area from which the ice is to be harvested.

Ice from a contaminated supply is very dangerous. If weeds and water plants grow in the pond they should be removed before the first freeze, since the plants, if allowed to freeze in the ice, will be deposited in the refrigerator the following summer, causing an odorous filth and making a good place for disease germs to develop.

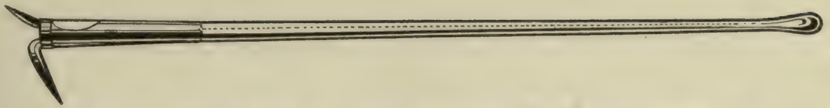
Ice should not be harvested from a pond which contains a green spawn or algae. The water can be rid of it by placing crystals of copper sulphate in a cloth sack hung to a pole and trailed through the water until the salts are dissolved. One or two treatments during the season at the rate of one pound of copper sulphate to 100,000 gallons of water will be sufficient to render the water safe to use.

In some cases a supply may be secured as the ice is going out in the spring, many miles from where it was formed. In the southern states floe ice, as this is called, is the only possible natural source of supply. Ice of a fair quality has been secured in this way at a small cost.

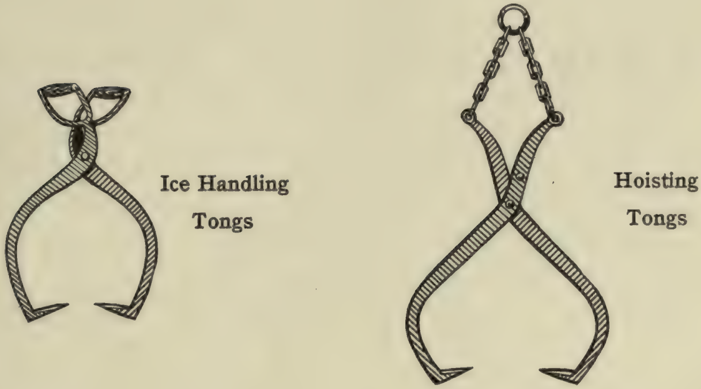
In places where there are no large bodies of water, but where the winters are cold enough, the can method of manufacturing may be used. This method requires a number of large cans 22 inches square or 22x32 inches, and from 12 to 15 inches deep, of heavy galvanized iron or black iron properly reinforced around the top with iron bands. The bottom should be somewhat smaller than the top so that the cakes may be easily removed and the danger of bursting lessened. The cans are filled with fresh water and placed outdoors. When a layer of ice 1½ inches thick has formed over the top the cans are turned bottom side up and the ice loosened by pouring hot water over them. The thin sheet of ice which formed at the bottom of the can (which is now the top) should be broken and all the water except two or three quarts poured out. When this is frozen a few more quarts of water may be added and so on until a solid block of ice is built up. By this method, using 25 cans, a supply of ice may be manufactured in a short time and at a small expense. The cans, if taken care of, will last for several years. Such a supply of ice is pure and free from vegetable and animal matter, which so often damage pond and river ice.

HOW TO HARVEST ICE.

The time and labor required to harvest the ice supply will depend upon the equipment and upon the location and condition of the field. Where ice is stored on the banks of a lake or river and power machinery used, it has been put up for three cents a ton. As ordinarily stored the cost will range from 18 to 20 cents per ton, to which the cost of hauling must be added. The equipment necessary for putting up small quantities of ice is two saws, two ice tongs, two ice hooks and a sharp pointed bar or spud. (See Fig. 1.)

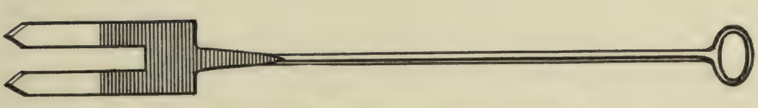


Ice Hook. This is used for pulling or pushing the floating cakes of ice.

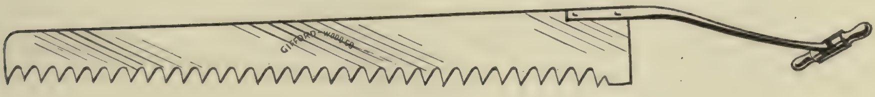


Ice Handling Tongs

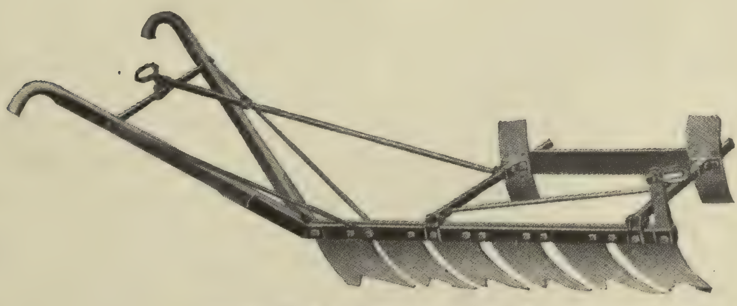
Hoisting Tongs



Splitting Fork used in breaking off floats or large sheets from the ice field.



Ice Saw.



An Ice Plow with marker attached.

FIG. 1. ICE HARVESTING EQUIPMENT.

It is often found convenient and profitable for three or four neighbors to co-operate in harvesting their ice supply. In this case a horse plow should be added to the equipment. The field may be laid off so as to cut the cakes to standard dimensions of either 22 inches square or 22 x 32 inches. Oblong cakes have the advantage over square ones, for they can be placed so that the joints lap and air currents prevented. If the joints are filled with crushed ice the cakes will freeze together, making one solid block which has a greatly reduced exposed surface area and in which there is no possible chance for air currents. Snow is sometimes used between the cakes, but is not so likely to cause them to freeze together. The removal of the ice is more difficult when solidly frozen together, and if it is well packed and insulated there is not much loss from air currents or melting between the cakes.

In order to obtain cakes of square or rectangular form, construct a right angle (like a carpenter's square) of light boards 12 to 16 feet long. Lines should be run parallel to both edges of this square for the full length of the field and afterwards accurately followed with a hand marker or saw. In using a hand saw, the line parallel to the open edge of the water is followed, after the first tier is removed, and cross cuts made to separate the individual blocks.

By the use of an ice plow with a marker attached the whole field may be cut into rectangles of the desired size. After the field has been plowed the cakes can be barred off and floated to the loading platform. Two men with ice tongs can load the cakes on the wagon. If desired, a chute can be constructed leading up to the platform level, with the wagon box and horse power used to elevate the ice.

These methods refer to the harvesting of ice from 6 to 18 inches thick. In localities where ice seldom freezes more than three or four inches in thickness somewhat different methods are used. Here the ice is usually broken up into more or less irregular cakes which are stored in as solid a form as is possible and crushed ice filled in around them. The storing of such ice requires a better insulated ice house, since there is a greater exposed surface of ice for the same tonnage and the storage season in such localities is usually longer with greater heat during the summer.

THE KIND OF ICE HOUSE TO BUILD

There are three general types of ice houses: (1) those built entirely above ground; (2) those built partly above and partly below ground; (3) and those of the cave type built entirely below ground. Of the three types, the structure built entirely above ground is usually to be preferred. It can be built more cheaply, insulation and drainage are better and the ice is easier to remove. The other two types of houses possess some slight advantages at the time of filling, but excavations are expensive. They are also hard to drain and it is more difficult to remove the ice. The temperature of the earth varies less than that of the air, but the temperature of the ground a few feet below the surface remains at a constant temperature throughout the year. It therefore becomes quite as necessary to protect the ice against the heat of the earth as that of the air.

The type built entirely above ground might be subdivided into (1) the house for storage only, and (2) the combined ice-house and cold storage room. The combined type has the advantage that the ice does not have to be handled after it is stored, but it is more wasteful of ice, as there is no way of saving the supply when only a small amount of refrigeration is needed.

THE SIZE TO BUILD.

The size of the ice-house will depend largely upon the quantity to be stored, the way in which the farm produce is marketed, and the amount of money which can be invested in the house. If the supply of ice is cheap and plentiful a larger but cheaper type of house can be built and more ice allowed to waste. Where ice is scarce it is advisable to build a better house which will waste less ice and require a less storage capacity. The best practice is to build a permanent and well insulated house, for the increased cost is largely offset in the saving of ice as well as in the smaller size of house.

From three to five tons of ice for the season will usually be sufficient for household use. On a dairy farm it is customary to allow 1,000 lbs. storage capacity per cow where only the cream is cooled, and two or three times this amount if the whole milk is cooled.

Ice weighs 57 pounds per cubic foot, or 35 cubic feet weigh one ton, but as ordinarily stored it requires from 40 to

50 cubic feet of space a ton, depending upon the size, thickness and care with which it is placed and packed. For a herd of thirty cows, where the cream alone is to be cooled, storage for fifteen tons of ice, plus five tons for household use, or a total of 20 tons, would be required. This amount of ice would occupy a volume of 800 cubic feet, and might easily be stored in a house 10x10x10 feet, the extra 200 cubic feet being taken up by insulating material.

Ice is a very perishable product, requiring an especially well insulated building for its preservation. Of all the practical shapes in which an ice house might be built a cube represents the greatest volume with the least exposed surface. In building an ice house a shape as near this as possible should be used. Advantage should be taken of any natural shade or shelter, and good drainage should be provided, for without it good insulation is impossible. In order that the greatest amount of use be made of the ice-house it should be convenient to the house and dairy.

PROPER INSULATION SAVES MONEY.

Insulation is the most important feature in ice-house construction, for upon it depends the keeping of the ice. As it is the most expensive part of the building, great care should be exercised in the choice of material and the placing of it. It is almost impossible to give any fixed value to different classes of insulating material because so much depends upon the care and method of using them.

In building an ice-house the problem is to minimize the passage of heat from the outer to the inner wall. There is no material known that will entirely prevent the passage of heat, but there are some materials through which it passes very slowly, and these are called insulators or non-conductors. Air permanently confined in a dead space is the ideal insulator. It was considered good practice at one time to incorporate these so-called dead air spaces in the walls of ice-houses, and much time and money has been spent building air space after air space of widths varying from three to twelve inches, only to find that they are not satisfactory. It has been found that an air space of ¾ inch is as effective as one of greater width. As a rule, continuous air spaces do not pay for the cost of material and labor put into the building of them, because workmen do not ordinarily exercise the care necessary to produce an absolutely air-tight compartment. Once the air is allowed an opening, moisture will be taken in and condensed on the studding, producing decay and destroying the insulating value of the material with which it comes in contact. But even when the air spaces are perfectly constructed they are of short duration, as they soon become leaky, due to shrinkage of lumber and settling of the building.

After the air spaces were found impracticable, different kinds of manufactured insulating materials came on the market. In general it may be said that the requirements of a good insulator are that it be a first-class, permanent non-conductor of heat, will not absorb moisture, and be practically fireproof. Most good non-conductors are porous and contain from 90 to 96 per cent of finely divided air spaces.

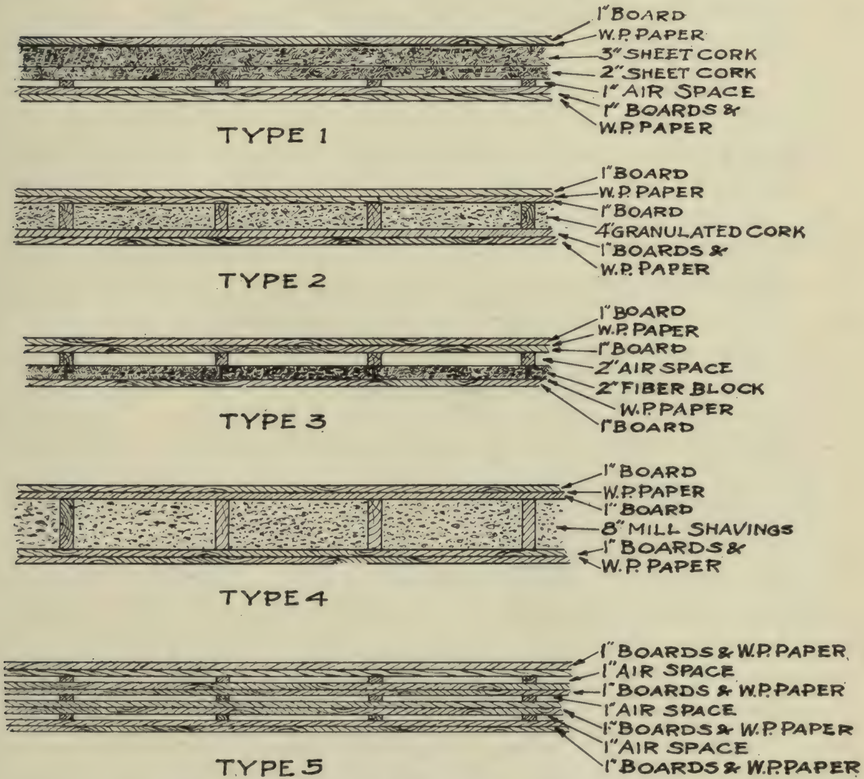


FIG. 2. INSULATING WALL CONSTRUCTION.

The relative insulating value of wall construction in Type 4 will depend upon whether the shavings are dry, damp or moist. If dry this construction will rank second, and if damp, third, of these methods of wall insulation.

Sawdust is the most common insulating material, because it is cheap, and, in many localities, easily obtained. Sawdust from woodworking factories is usually dry, but from other sources it is likely to come from green lumber and be wet. Wet sawdust moulds quickly, as it has the elements of decay in it before it is ever placed in the building. Dampness not only causes the sawdust to rot and settle, leaving uninsulated spaces in the wall, but also reduces the value of the insulating material about one-half. Beams and joists around which it is packed decay, producing an objectionable odor, resulting in the final ruin of the structure. Sawdust should never be used, except in very cheap buildings, unless thoroughly dry and so protected that it will always remain so.

Other materials of about the same class as sawdust are cotton seed hulls, chaff, leaves and cut straw. Mill shavings are more expensive than sawdust, but are quite commonly used. They are usually dry, since they come from the outside of the lumber, which is its dryest portion. Shavings are baled and stored under cover. In such form they are convenient to handle, and usually sell for from 15 cents to 25 cents per 100 lbs. Shavings are elastic, do not settle readily, do not absorb moisture as easily as sawdust and are free from dirt, bark and chips. Shavings from softwoods which are odorless and not as brittle as those of hardwoods, are preferable. Shavings which are damp but which have not started to mould may be dried out and used.

Mineral wool, known also as granite rock wool, slag wool, rock cotton or rock cork, is a good insulator in spite of the fact that it is made from a material which has a relatively high conductivity. Slag wool contains about 92 per cent air space, while the best rock wool when loosely packed contains 96 per cent. While mineral wool will not rot, it needs perfect protection from dampness, for it absorbs moisture readily. If the moisture freezes in the wool the expansion breaks the brittle fibres and thus its insulating value is destroyed. When the wool thaws out it will settle, leaving large unprotected spaces in the wall. Mineral wool costs from $25 to $30 per ton and, as ordinarily placed, will cost four cents per square foot per inch of thickness. Mineral wool should be free from all solid pieces and when placed in the wall should be packed in at the rate of 12 lbs. per cu. ft. Any greater density destroys its insulating value. Workmen do not like to handle mineral wool, as it pricks the hands and little pieces floating in the air are hard on eyes and lungs, all of which may cause the work to be slighted.

One of the most efficient and high grade insulating materials available is cork. It, perhaps, comes as near fulfilling all the requirements of a good insulator as any material used, as it is made up of innumerable sealed air cells, which prevent the passage of both heat and moisture. Cork is very slow burning and when coated with cement becomes practically fireproof. It also has the advantage of being odorless, clean, elastic and durable.

Cork may be had in either sheet, block or granulated form. The sheets are of two varieties, the pure cork and impregnated. Cork sheets come in thicknesses of 1, 2 and 3 inches, and are usually 12x36 inches. It is very convenient to handle and very efficient, as only a small space need be sacrificed in insulation. There is no danger of its settling in the walls and by applying a cement finish a permanent, damp proof and fireproof insulator is provided. Eight to ten pounds of granulated cork per cubic foot makes a good insulator. While cork will not absorb moisture to any considerable extent, it will rot if exposed to constant wetting and drying. For this reason the damp proofing is important. Where ground cork is used in floors it should be covered with a double thickness of matched boards, between which two layers of waterproof paper have been placed. Where sheet cork is used in floor construction the sheets should be set in hot pitch or asphalt and the exposed surface completely covered with the preparation before applying the cement coating. Sheet cork used on wood floors should be covered the same as the granulated cork. For ordinary cold storage rooms and ice houses a 3-inch layer of sheet cork is sufficient and will cost from four to six cents per square foot per inch of thickness.

Hair is nature's insulator. It is very efficient and quite indestructible. Twenty-four inch widths of hair quilt are applied between furring strips and paper. No nails should be driven through the material. Cross cleats may be used if the felt tends to sag from the ceiling, but should be removed as the inside wood finish is put into place. Twine may be used in place of cleats. Extreme care should be taken in placing both the hair felt and the paper, for poor workmanship will spoil the value of a high grade paper and insulation. Hair felt has a great affinity for moisture and when not protected from it absorbs it freely, displacing the air. In this condition it becomes practically worthless as an insulator.

All good insulators are more or less porous and hence must be provided with a perfect air seal to prevent the entering of air and moisture, causing condensation and consequent decay of the material. Paper is not a good insulator. It merely serves as a seal. The requirements of a good paper are that it be odorless, strong, durable, pliable, ductile (not brittle). Papers which are rosin sized, oiled, tar coated, or saturated should be avoided. Paper impregnated with pure asphalt is the best and cheapest in the end, as it costs less than five per cent of the total cost of the insulation to use a high grade paper. When the paper is applied the joints should be lapped at least 2 inches and in some cases cemented. As water proofness and air tightness are vital features in good insulation, the application of the paper which controls these two factors to a large extent is a very important part of the insulation. Asphalt for waterproofing is worth about $40 per ton and will cost about 2½ cents per square foot of coated surface. Good paper will cost from $2.50 to $5.00 per 1,000 sq. ft., depending upon the number of plies.

FOUNDATIONS AND FLOORS

It pays to build a good foundation and floor. The earth is a fairly good conductor of heat, especially if saturated with water, as it is sure to be below the ice house, so insulation here is quite as important as in the walls. In case only a dirt floor is to be provided, the earth should be excavated to a depth of 12 to 18 inches. Fill in with cinders or gravel and a few inches of straw or some material which will prevent the sawdust from being washed down into the cinders or gravel. The layer of sawdust should be 12 inches thick. This will provide a foundation which is always dry and it will be quite an effective insulator.

Where permanent floors are put in the filling of gravel or cinders should be provided and a good insulating material placed in the floor. A drain should be built to carry away rapidly all the water from the melting ice and this drain should be trapped to prevent the entering of air. In some cases the water is caught in a tank and used for cooling purposes. The floors should slope from all directions toward the center to prevent the ice falling against the walls and to carry the water to the drain.

USE GOOD MATERIALS IN BUILDING WALLS

Having decided upon the insulating material that will be the most economical, the method of placing it is the next question. Several good designs are shown in Fig. 2 in order as to their relative efficiency as an insulator. High grade sheet material, such as cork, shows the least condensation, so if they are going to be used in the wall it should be placed next to the ice where the best materials are needed. If some loose material, as sawdust or shavings, is to be used the space in which it is stored should be divided into divisions from 10 to 12 inches to prevent settling and penetration of moisture. In designing a wall it should be remembered that heat passes through a material of uniform density more readily than through one made of successive layers of different densities.

WOOD ROOF IS BEST

Roofs are usually of the gable type and for ordinary construction 2x6-inch rafters and 1-inch sheathing are used. One-quarter pitch roofs are common and good shingles will be found satisfactory. Either cut or zinc-coated shingle nails should be used. Wire nails rust too quickly.

BUILD TIGHT DOORS

Doors are a weak point in the insulation of most farm ice houses, and it will quite often pay to have some concern which is in the business make the doors in preference to an inexperienced carpenter.

In houses which are used for storage only a continuous door should be provided to facilitate the filling and removing of the ice. The doors should be as well insulated as any other part of the wall and should be provided with clamps, which will enable one to close the doors absolutely tight, thereby preventing any leakage of air. The doors are usually beveled and closed against some material, as felt, which makes a good seal. If loose insulating material is used around the ice, a built-up door should be provided to keep it away from the outside door. Where combined ice house and cold store rooms are built great care should be taken in the construction of the door to the cold storage room, as this door is opened so frequently that losses will occur, due to poorly designed doors. The door should open and close easily and quickly from both sides, and when closed it should prevent the leakage of air. A three-foot door is large enough for all ordinary purposes. All windows should be at least double and rigidly fastened in place.

ICE HOUSE NEEDS VENTILATION

All ice houses should be provided with some means of ventilation, to aid in breaking up the heat radiation of the roof and to carry off moisture. When the ice house is opened the cold air will literally fall out and be replaced with warm air, which, when the ice house is closed again, will, unless given a chance to escape, use considerable refrigeration before it is cooled down to the temperature of the ice. To reduce this loss a door is provided above the ice, which is opened just after the day's supply of ice is removed and should be tightly closed soon afterwards.

When houses are exposed to the direct rays of the sun it is well to provide some means of circulating air in the walls to break up the heat radiation, as shown in Fig. 2.

USE ODORLESS WOODS IN COLD STORAGE ROOMS

The best wood to use in building cold storage rooms will depend on the most available wood. It should be odorless and free from all defects. Wood with a slight odor should be whitewashed to prevent the stored products becoming tainted. The lumber should be thoroughly dried

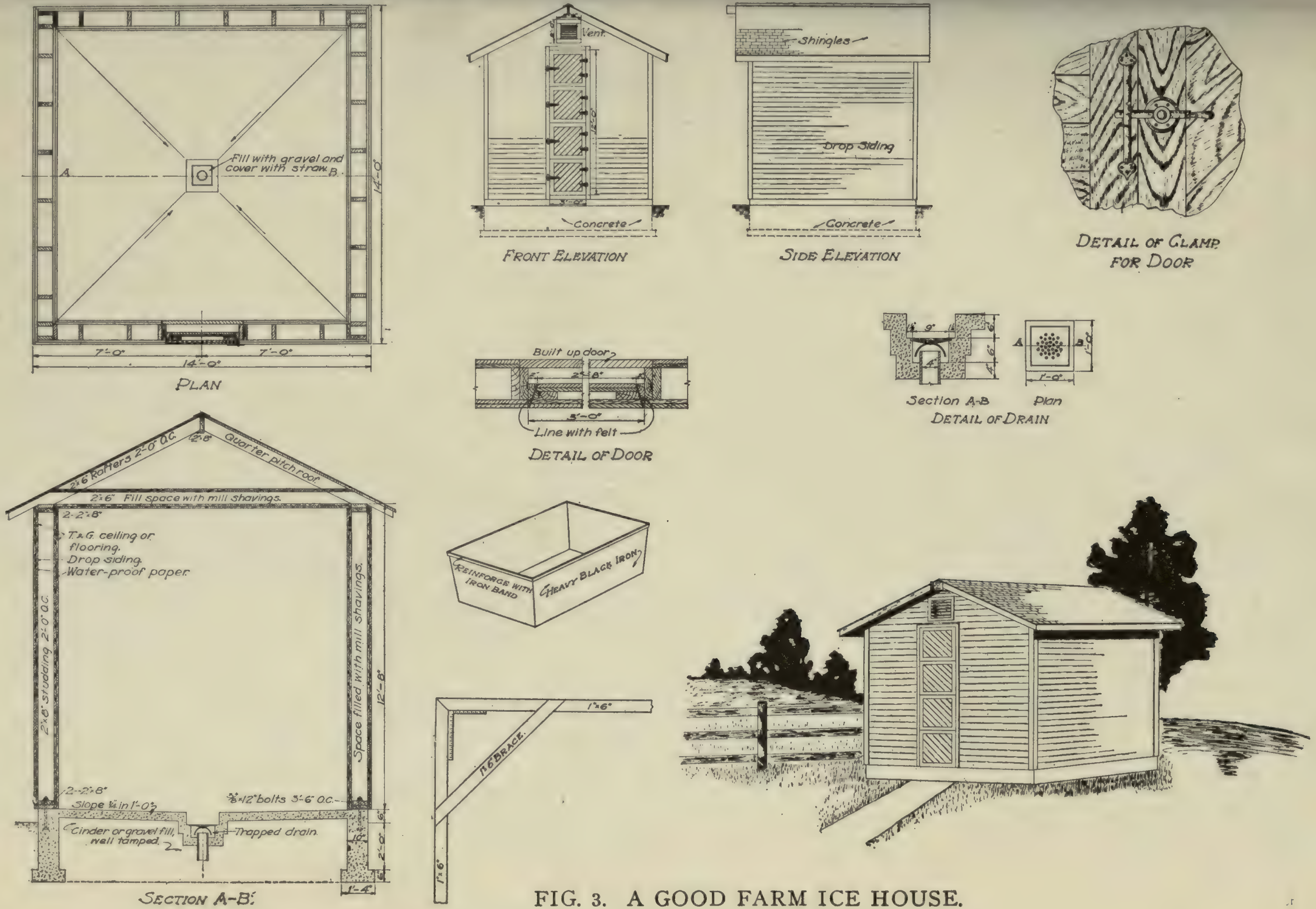


FIG. 3. A GOOD FARM ICE HOUSE.

to prevent moisture being carried into the insulation and during construction in cold weather a fire should be built to keep the lumber dry.

Nails are good conductors of heat, so the kind and manner of using them is of some importance. Cement coated wire box nails are considered best, as smaller diameters and shorter lengths can be used without sacrificing holding power. Six and eight penny cement coated nails may be substituted for 8 and 10 d. common nails and, due to the smaller size, the heat transmission will be reduced. The coating also prevents rust.

A GOOD FARM ICE HOUSE

The accompanying design, Fig. 3, is planned for a farm ice house of the storage type. It has a capacity of approximately 40 tons, which is a sufficient supply for an average dairy farm having a herd of from 30 to 60 cows. The amount of ice used will depend upon the manner in which the milk is handled as well as the length of the storage season.

The foundation and floor are of concrete, placed upon a well compacted sub-grade of cinders or gravel. The floor has a slope of ¼-inch to the foot toward the drain. If it is very important to keep down the cost of construction the concrete floor may be omitted and a foot of sawdust substituted. The sills are made of two 2x8-inch planks securely bolted to the foundation with ⅝-inch bolts placed every 3½ feet. It is a good plan to creosote the sills, so as to prevent decay. Two layers of ceiling or flooring are placed on both sides of 2x8-inch studding forming the walls. The ceiling is made of two layers of matched lumber nailed to both sides of 2x6-inch joist. Waterproof paper is placed between the matched lumber in both the walls and ceiling and the space between the studding and joist is filled with mill shavings, not sawdust.

The roof is quarter pitch made of 2x6-inch rafters and shingles. The 2x8-inch ridge piece is extended at one end to provide a place for fastening a block and tackle when ice is being stored in or removed from the house. A ventilator two feet square is placed at both gable ends of the building to permit the free circulation of air in the attic and thus prevent the penetration of heat from the roof.

A trapped drain is provided to carry away the water from the melting ice and at the same time prevent the circulation of air. This drain may be made as shown in the illustration, or some commercial form of trap may be installed. The space above the trap should be filled with gravel and this in turn covered with straw to prevent any possibility of trash being washed into and clogging up the drain.

The doors should be well built and tightly fitted. The edge of the doors or casings against which they close should be covered with felt. A good clamp should be provided for each door so that an air-tight joint will be formed when it is closed. A built up door of 2-inch material is placed next to the ice and the space between it and the outside door packed with shavings.

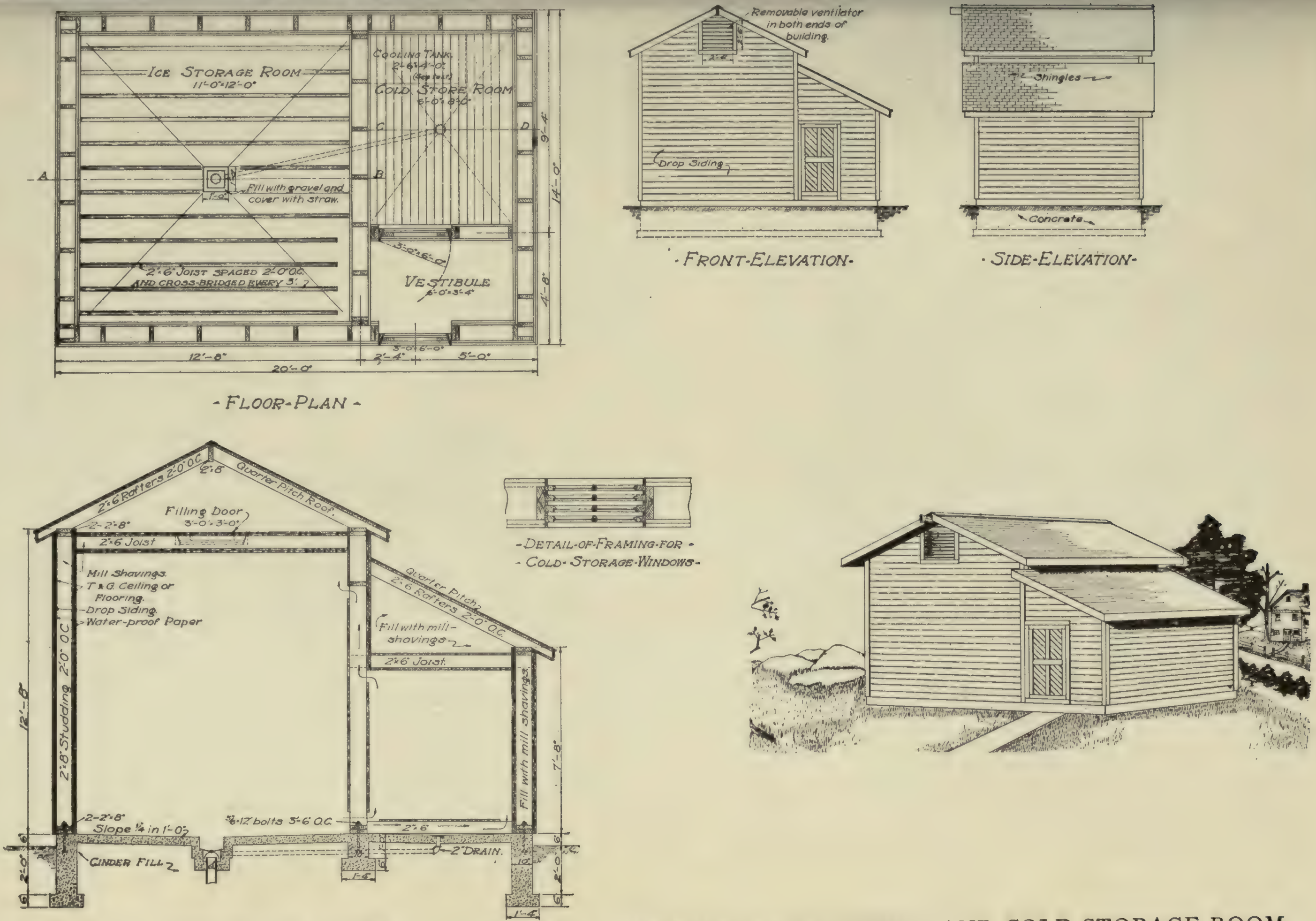
Where ice is expensive and the storage season long, it will probably be found more economical to use some better grade of insulating material.

A COMBINATION ICE HOUSE AND COLD STORAGE ROOM

Plans for a combined ice house and cold storage room are shown in Fig. 4. This type of ice house operates on the same principle as a refrigerator. The cold store room is kept at practically the same temperature as that of the ice storage room, due to the continual circulation of air. This circulation is caused by the difference in the weight of air at various temperatures. The warm air from the cold store room rises to the ceiling and then passes up between the studding of the partition and out over the ice in the ice storage room where it gradually becomes colder and heavier. The cold air surrounding the ice flows out between the floor joist of the ice storage room into the cold storage room, and gradually rises as it is warmed and finally passes back into the ice storage room. This circulation is kept up as long as there is any difference in temperature between the two rooms.

The foundation and floor are made of concrete placed upon a well compacted sub-base of cinders or gravel. On this base a four-inch concrete floor is placed. The foundation wall is ten inches thick with a sixteen-inch footing. Both the cold storage room and the ice bunker are provided with drains, the one in the ice bunker being trapped to prevent the circulation of air. The concrete floor in both rooms slopes one-quarter of an inch to the foot toward the center, causing the water to drain off readily and preventing unnecessary wasting of the ice. Two-inch by six-inch floor joists are placed in both rooms to permit the free circulation of air between the ice bunker and the cold store room. A floor of matched lumber is laid on the joist in the cold store room to within six inches of both walls, these openings being left for the circulation of air.

The walls are made up of 2x8-inch studding to both sides of which two layers of matched lumber are nailed. A good grade of waterproof paper is placed between both layers of matched lumber to prevent air and moisture entering the space between the studding. This space is then filled with mill shavings, packed in at the rate of eight or nine pounds per cubic foot. The ceiling construction is exactly the same as that used in the wall except that 2x6-inch joists are used in place of the 2x8-inch studding. The ice is put in through a trap door which is placed in the ceiling just inside the ventilator. This door is closed tightly after the ice house is filled and need not be opened until the following season at filling time. The 2x8-inch ridge piece projects beyond the end of the building to provide a place for fastening a block and tackle to be used when the ice is harvested. The roof is one-quarter pitch made up of 2x6-inch rafters one-inch sheathing, and shingles placed over both the cold store room and ice storage room. It will be found somewhat of a saving to use the "lean-to" construction rather than to cover the entire building with one gable roof as the amount of siding and length of studding is reduced.



- FLOOR-PLAN -

· FRONT-ELEVATION ·

· SIDE-ELEVATION ·

- DETAIL-OF-FRAMING-FOR -
- COLD-STORAGE-WINDOWS -

- SECTION-ON-A-B-AND-C-D -

FIG. 1. A COMBINATION ICE HOUSE AND COLD STORAGE ROOM.

A removable ventilator is placed in each gable end of the building to permit the free circulation of air in the attic and thus prevent the penetration of heat from the roof.

The doors may be made as suggested in the drawing or purchased from some company which makes a business of manufacturing refrigerator doors. In either case it should be remembered that a good door is of primary importance in this type of an ice house and care should be taken to secure one which will open easily from either side, and when closed make an absolutely air-tight joint.

To reduce the refrigeration loss caused by the door being opened while entering or leaving the cold store room, a vestibule is provided which makes it possible to keep one or the other of the doors closed at all times and thus prevent any direct flow of air between the inside and outside.

If it is found desirable to put a window in the vestibule at least four-inch sash should be used as shown in the drawing and fastened rigidly in place.

A cooling tank of concrete located as shown by the dotted lines in the plan, through which the water from the melting ice passes before leaving the building, would be of considerable value where quantities of milk or cream are being cooled. Such a tank should be about 2 feet 6 inches deep by 4 feet wide and six feet long. It should be provided with an overflow pipe fitted with an "L" and nipple projecting below the high-water level of the tank. The trapped drain in this case would not be needed.

A Homemade Ice Box Easily Constructed

Where one does not wish to go to any great expense for a refrigerator, a cheap and very satisfactory ice box can be constructed as shown in the accompanying plans. (Fig. 5.)

The frame of the ice box is made of 2 x 4s on both sides of which two layers of matched lumber are nailed. Waterproof paper is placed between the matched lumber. The space between the inner and outer wall is filled with dry mill shavings.

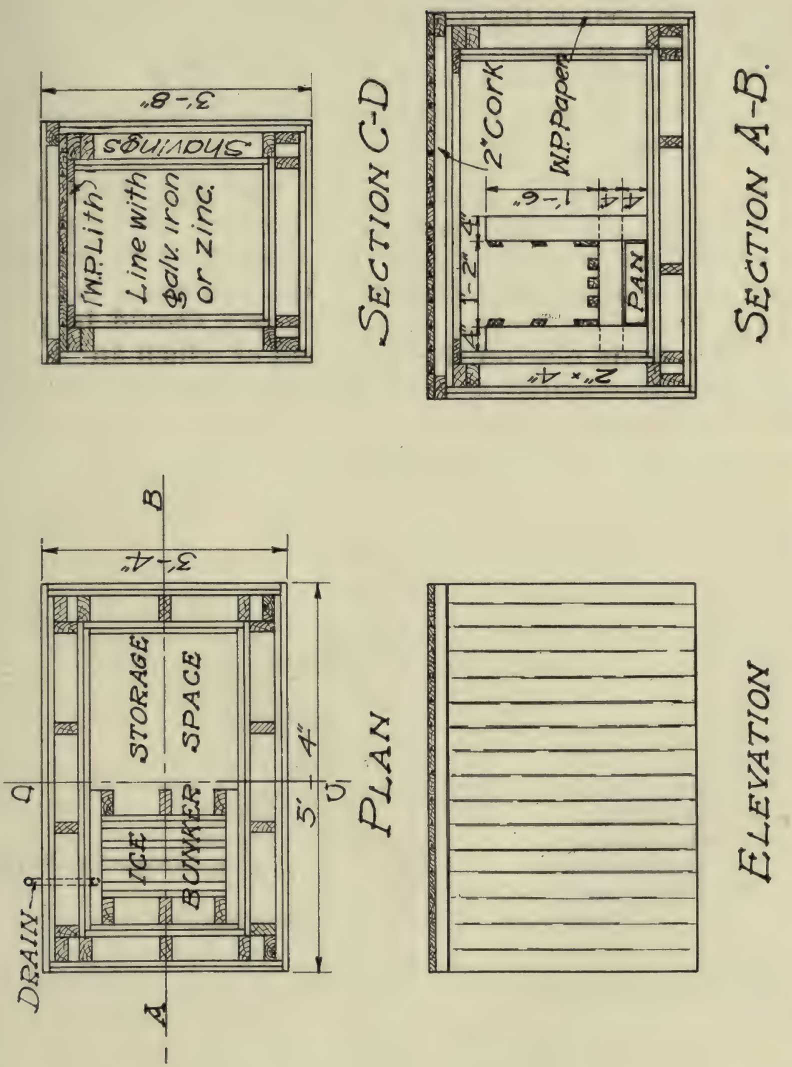


FIG. 4. A HOME-MADE ICE BOX.

The cover is made of a 2x4-inch frame to both sides of which waterproof paper and matched lumber are nailed. On the under side a frame of 1x4-inch material is nailed, and in the space on the inside of it a 1-inch sheet of waterproof insulating material is fastened. The entire lower surface of the door, as well as the inside of the box, is covered with galvanized iron or zinc. This cover is quite heavy and should be provided with a counterweight. Three heavy 5-inch hinges should be used and some good clamp provided to seal the cover.

The ice bunker is made up of 2 x 4s with 2 x 2 inch cleats for the ice to rest upon and 1 x 2-inch cleats at the sides beveled so that water will drain off of them readily. A galvanized iron pan is placed below the ice bunker to catch the water from the melting ice. This pan should be provided with a drain pipe on the outer end of which an "L" is placed with its opening upward so that the drain will be sealed at all times.

Other Farm Bulletins.

Other Bulletins in this series are upon:

Dairy and General Purpose Barns
Horse Barns
Hog Houses
Poultry Houses
Farm Residences
Implement Sheds
Silos
Garages
Grain Storage Buildings
The Preservative Treatment of Farm Timbers

Ask for those that will be helpful to you. Address:

National Lumber Manufacturers Association
Lumber Exchange
Chicago

Ice weighs 57 pounds per cubic foot or 35 cubic feet to one ton.

Three to five tons of ice are enough for household use.

Allow 1,000 pounds of ice per cow for cooling cream alone; if whole milk is cooled allow 2,000 to 3,000 pounds.

From 40 to 50 cubic feet of storage space, including insulating material, is required per ton of ice.

Wood "Where Best"

The legitimate use of lumber where it is best, or by proper selection or treatment, can be made to serve economically and safely, is the aim of the lumbermen in publishing a series of bulletins on Farm Structures. Wood has for so long been the most widely used building material that its availability and importance have either been taken for granted or lost sight of. It is helpful to review the outstanding features of the present situation:

Wood remains the most universal, most adaptable building material in the world.

The supply is ample for all requirements, and the kinds and grades best suited for all purposes are obtainable everywhere.

In cost it remains one of the cheapest materials.

It is the lightest building material known, and the strongest, weight for weight.

Its qualities are known; it is easy to work; it can be cut and shaped by any one into the myriad uses required for the shelter and comfort of man.

There is no material more beautiful in appearance, more susceptible to artistic finish, nor which is as productive of sentiment and satisfaction for home building.

Wood is a non-conductor of heat,—cool in summer and warm in winter.

The relative qualities of durability, serviceability and workability should be considered in selecting wood for homes and farm buildings. Consult the local lumber dealer. His knowledge and advice will assure cheaper, more stable buildings.

Except where naturally durable woods are available, a preservative treatment will prove economical for timber exposed to moisture and decay, as sills, basement flooring, fence posts, and in similar situations.

Dairy and General Purpose Barns

by

F. M. White

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IN A NUT SHELL.

A well-built, well-lighted, well-ventilated, and well-planned barn is a necessity on nearly every live stock farm. The cost of the barn may vary, for some farmers will install more elaborate conveniences and pay more for architectural style than will others.

Barns are practically standardized, in regard to framing and interior arrangement. The cost of wood and other materials makes it necessary to make a more careful study if savings are to be made.

Build a barn large enough to meet future needs and to permit the handling of the maximum capacity of the farm. If the new barn just holds the stock at time of building another barn will probably be needed soon.

The location and drainage of the barn are important. The location should be at least 200 feet from the house and handy to a well, sheds and granaries. Drainage is necessary if the stock is to be kept healthy.

Rectangular shaped barns are more satisfactory than round ones. In northern latitudes, the barn should have its length run north and south if the largest possible amount of direct sunlight is to be let inside.

A ventilation system is required if the animals are kept healthy. It also regulates the temperature and furnishes fresh air.

The barn must be kept clean. The manure can either be removed every day or the stalls bedded heavily and the manure removed every week. It is best to clean out the barn every day.

Gambrel roofs give more room for hay than do the gable roofs. This is an important point to consider.

For the foundation and subfloor of the barn concrete is the best product that can be used. Sand and gravel are often found on the farm where the barn is built. Concrete must be well mixed and reinforced if it is to give the best of satisfaction.

Creosoted wood blocks make an excellent floor for stables and stalls over a concrete subfloor, being permanent and sanitary.

Plans are described in this bulletin for three general purpose barns, one single story dairy barn, a pioneer barn and a round dairy barn. Blue prints can be secured from the National Lumber Manufacturers' Association.

Dairy and General Purpose Barns

By F. M. White

A well constructed, well lighted and well ventilated barn is a necessity on any well equipped farm. Fresh air is essential to health. Sunlight is one of the most powerful disease-destroying agencies known. A building affording these properties and at the same time giving ample shelter from the winter cold and summer heat is the object sought in the construction of barns in northern and southern as well as eastern and western states.

Conditions vary so in the various sections of the United States and upon the different types of farms that no one plan will meet the demand of every one. In the southern sections of the United States it will not be necessary to construct barns as warm as in the northern latitudes. Then, too, one man may care to consider mainly ways of reducing the need of labor; another may plan his barn so as to aid him in the display of his stock while another may be willing to spend more for architectural style and conveniences.

Barn building, however, so far as design of framing and interior arrangement are concerned, is rapidly becoming standardized. The general requirements of barns are very similar, and the six designs described at the end of this bulletin and which may be secured from the National Lumber Manufacturers Association, are planned to meet as nearly as possible the needs of the practical farmer.

NOTE:—This bulletin has been revised from a recent publication issued by the College of Agriculture of the University of Wisconsin. We are also indebted to this institution for the loan of the cuts used in this publication.

In the past, barn framing has been done by "rule of thumb." In order to save material and to insure the necessary rigidity of the structure, more attention is now being given to the strength of materials and to matters of design.

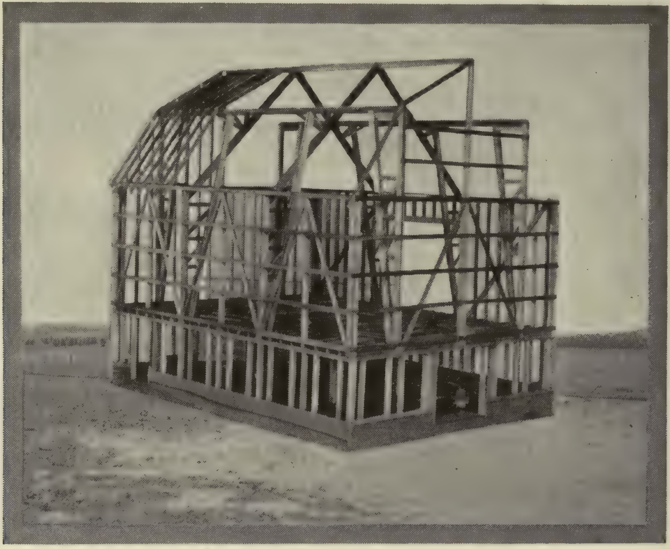


Fig. 1. Plank Frame Construction Reduces the Lumber Bill.
In building a farm barn it is important that the cost be kept as low as possible without sacrificing comfort, convenience or strength.

Build to Meet Future Needs

A barn should not be built just large enough to accommodate the stock on the farm at the time of its building. A good manager considers his farm as a factory and expects to work his "plant" to its maximum economic capacity. The barn is an important part of the farm factory plant and should be large enough to accommodate all the animals the manager can care for efficiently. The size can be determined only after a careful study of the number of acres in the farm and the quality of stock.

Over capitalization is perhaps as poor a policy as under capitalization. But the dairy farmer, especially, can afford to have a substantial, well arranged, well lighted, and well ventilated building.

Build on Well Drained Site.

The first essential of a barn site is proper drainage. With basement barns it is difficult to obtain perfect drainage. The chief object in building a basement barn is, as a rule, to provide an easy driveway into the second floor; but as hay and grain can be elevated easily or a bridge built leading to the second floor, light and drainage should not be sacrificed for the doubtful advantage of having a basement.

A driveway can be built to the second floor that will not shut out indirect light. In order to do this a concrete or stone wall needs to be built about eight feet from the barn and either a reinforced concrete bridge or a wooden bridge should connect the drive with the barn. The driveway in the barn should be from 12 to 14 feet wide, and the drive approaching the barn about 10 feet in width. It is expensive to give up space in the barn for a driveway, for in reality, very little use is made of it. Ordinarily such a driveway is used largely to drive into if caught with a load of hay on the wagon during a rain storm. Several tarpaulins large enough to supply this need can be purchased at a less annual expense than that incurred by the driveway.

Locating the Farm Buildings

The arrangement of the yards and fields, and the location of the well, machinery shed and granaries should be considered carefully in locating the barn. It should be at least 200 feet from the house and in such a position that the prevailing winds do not carry the odors from the barn towards the house. Under the best sanitary conditions possible there will be some odor from the barn and the amount of time saved in going to and from the barn by having it close to the house will not be due compensation for enduring the obnoxious odors. The barn should not be made the most conspicuous farm building. It is secondary to the house and should be so located as not to obstruct views from the house. Usually a location at one side and somewhat to the rear of the house will be found the most suitable.

If it is impossible to have drives leading both to the barn and to the house, the barn should be so located that either the service drive or a branch of it may be made to serve the house. This does not mean that a drive must come within a few feet of the house, as is so many times the case, but it should be convenient. It is undesirable to have the service drive for the barn, over which heavy hauling and delivery of hay and straw is to take place, close to the house. The drive should be so located that it may be screened off by the proper planting of the lawn surrounding the house.

Rectangular Barns Most Common

There are two general shapes of barns, round and rectangular. The great majority of barns are rectangular. While there are differences of opinion as to the relative merits of the two shapes it is generally considered that the rectangular plank-frame construction is the more standard and satisfactory.

The best arguments for the round barn are:

(1) As a greater area can be enclosed by a circle than by a rectangle of the same wall length, it is cheaper to enclose a given floor area by a circular than by a rectangular wall; (2) Circular construction is claimed to be stronger and to give greater convenience.

Some of the objections to the round barn and the advantages claimed for rectangular construction are:

(1) In a round barn the silo must, for convenience in feeding and for roof support, be located in the center. This location is inconvenient for filling, and unless care is taken in keeping silage cleaned up the odor from it is objectionable; (2) Unless designed for a dairy barn and all interior arrangements are circular in form, there is much waste space. A certain sacrifice of stable and hay-mow-room is made by locating the silo in the barn; (3) As the hay must be unloaded inside a barn bridge leading to the second floor is required. Barn bridges are not always convenient and much space is wasted from the floor to the roof where hay is drawn up; (4) The center of the barn is poorly lighted, which in a dairy barn is a very objectionable point; (5) The construction of a round barn prohibits the economic use of rafters for if they are placed the proper distance apart at the plate they are too close at the top; and (6) There is considerable difficulty in securing carpenters experienced in round barn construction; (7) It is more difficult to secure proper ventilation in a round than a rectangular barn.

Sunlight Is the Best Disinfectant

A barn should be lighted, so far as is possible, by direct sunlight. Sunlight is a great disinfectant and the best sanitary conditions can be obtained only in a well lighted barn. Darkness and dampness are serious objections to bank barns. The only good point in favor of the bank barn is warmth. Warm basements with good walls may be secured by building in a sheltered spot or by having a bank not over four feet high on one side. Window space should never be sacrificed for a bank barn.

A wide wall of stone cuts off much light and if used at all it should be cut at an angle of 45 degrees from the inner edge of the window.

The amount of lighting surface required in a barn is four square feet of window glass to each animal, or one square foot of glass for 20 square feet of floor space. The amount of direct sunlight entering through any window will depend on the length of the window, rather than on the width, the length of the overhanging eaves and the thickness of the wall. The long dimensions of all windows for barns should be up and down.

It is a mistake to put windows in a barn with the long dimensions horizontal. Up and down windows admit the sunlight further into the barn. This arrangement decreases the amount of sunlight cut out by the ordinary 18-inch stone wall.

The direction in which the barn stands has much to do with the amount of direct sunlight that enters it. In northern latitudes, if the barn stands east and west, direct sunlight enters only through the south, east and west windows, and only indirect sunlight on the north. A barn standing north and south receives direct sunlight on both of the longest dimensions each day, or on the east and west, as well as on the south side, and indirect on the north side. In southern latitudes much direct sunlight will come in at north windows. As far as possible, buildings should be lighted from the south in the middle northern latitudes, as the maximum amount of direct sunlight may thus be obtained, by either an east and west or north and south arrangement, provided windows are not obstructed in either position. The barn should be placed with long dimensions north and south if a bridge or bank is to be built to the second floor. A barn standing north and south is generally cooler in the summer time as the prevailing winds from the south and southwest create a draft through the barn. In the winter time there is very little difference as far as temperature is concerned.

Ventilation Necessary to Animal Health.

Barn ventilation is necessary to regulate temperature, to remove the moisture and bad air and to provide fresh air. When human beings live in poorly ventilated rooms their efficiency is reduced and they are easily attacked by disease. The effect on animals may be expected to be the same. Poor ventilation in stables is easily detected by an accumulation of moisture on the walls and ceiling during warm weather, and by frost in cold weather. In Wisconsin, where it is necessary to keep animals in the barn during the winter, it is absolutely essential to have a ventilating system.

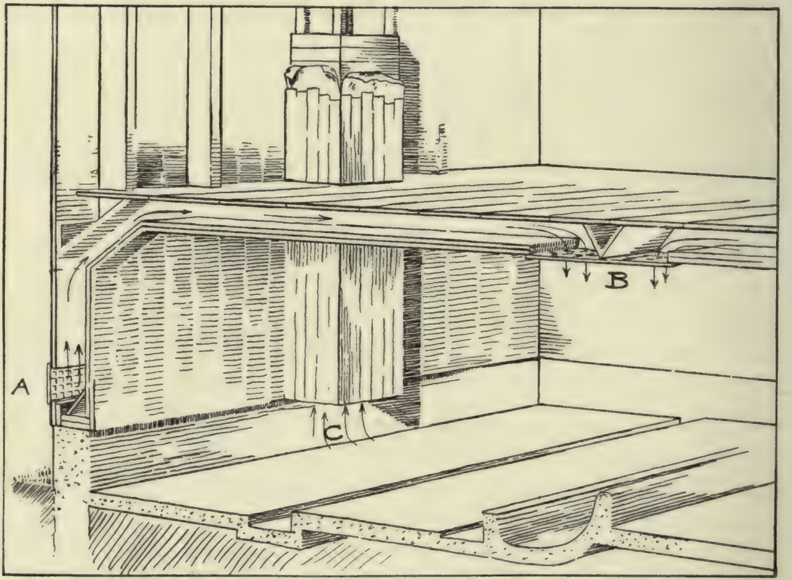


Fig. 2. Letting Fresh Air In and Foul Air Out.
The arrows show how the air is brought into the barn through the inlets and the foul air drawn out at the outlets.

The King system of ventilation, devised by the late F. H. King, for years connected with the Wisconsin Experiment Station has come to be generally adopted for barn ventilation. It has been widely used in all climates and has proven as satisfactory as can be expected from a partially automatic system. No ventilating system yet devised is entirely automatic, so even the King system will need some attention. In the extreme north the temperature is at times so low that an adequate supply of air cannot be furnished without producing too low a temperature in the barn, but under general temperature conditions it is possible to ventilate the barn adequately, if the proper attention is given to the King system.

The efficiency of the King system depends upon the location, size and straightness of the intake flues and outlet flues, practically air-tight, non-conducting walls and ceiling, and good tight doors and windows. As in any natural or automatic system of ventilation, no provision can be made to warm the incoming fresh air except the heat supplied from the bodies of the animals. The fresh air is warmed by mixing it with the warm air of the barn at the ceiling before it is breathed.

These fresh air intakes are located at 12 to 14 feet intervals along the side of the barn wall. The minimum length of the flue must be five feet between A and B, Figure 3, so as to guard against air flowing outward. It is very important that the inlet flue be covered with fine wire screening to prevent the flue from becoming obstructed. The valve or register should be arranged

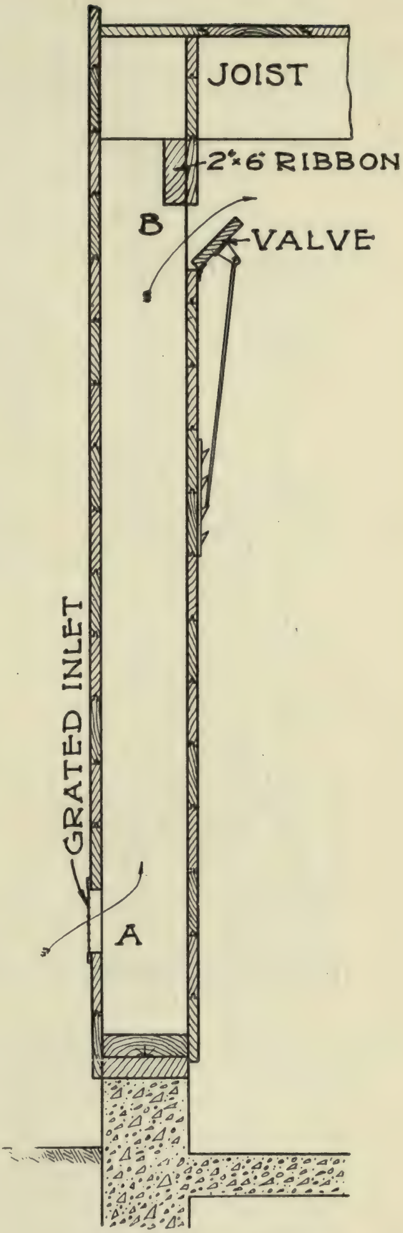


Fig. 3. A Valve Intake

The amount of air entering barn can be controlled by the valve built in some intake flues. The distance between A and B should be not less than 5 feet.

to open and close so as to prevent drafts in the barn and to keep the stable from becoming too cold during the extreme winter season. A register, similar to those used for hot-air furnaces, may be installed in place of the damper.

The foul air flues are made of galvanized iron, insulated, or of paper and lumber. The design of these flues is of the greatest importance to the success of the ventilating system.

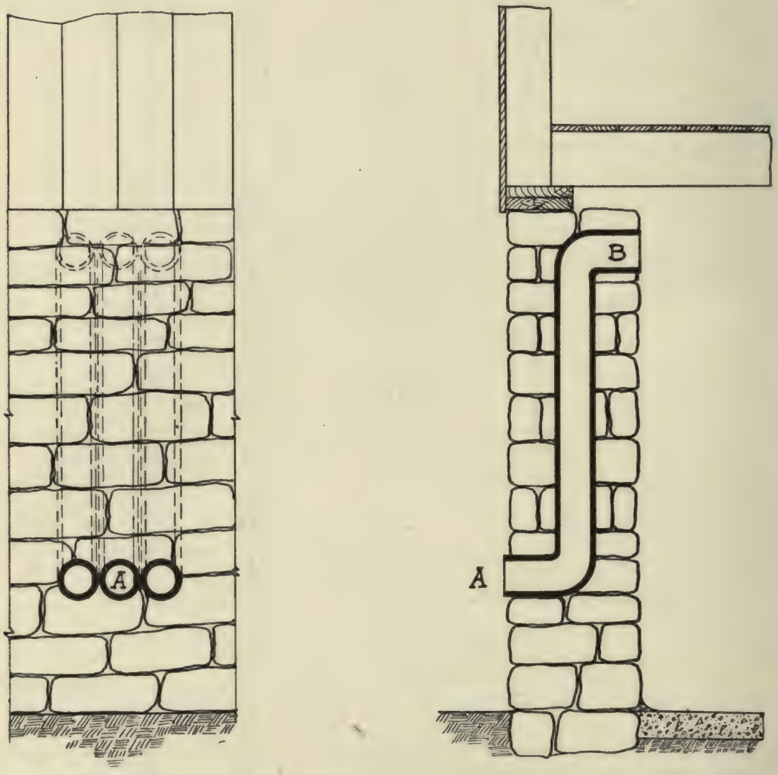


Fig. 4. Inlet Flue in Stone Wall.
Vitrified sewer tile or galvanized iron pipe may be used to provide the air passage in masonry wall.

They should be as straight and smooth as possible for every turn or bend reduces the carrying capacity of the flue. If it is necessary to pass around a bend, the flue should be enlarged so that its capacity will not be reduced. The ventilating flue acts as a chimney and should, therefore, rise above the highest part of the building in order to receive the full force of the wind. The velocity of the wind, as well as the difference in temperature between the inside and outside, make the flue draw.

It is important that great care be taken in locating the outlet flues. These should not be placed too close to the heads of the cattle for if they are, all of the foul air will pass directly by the animals and much of it will be breathed in by them. Neither should the outlet flue be placed near the entrance where the opening of the door would break the drawing action of the flue. The outlet flues should be so located as to be out of the way as much as possible and yet be so distributed about the stable as most readily to draw out the foul air.

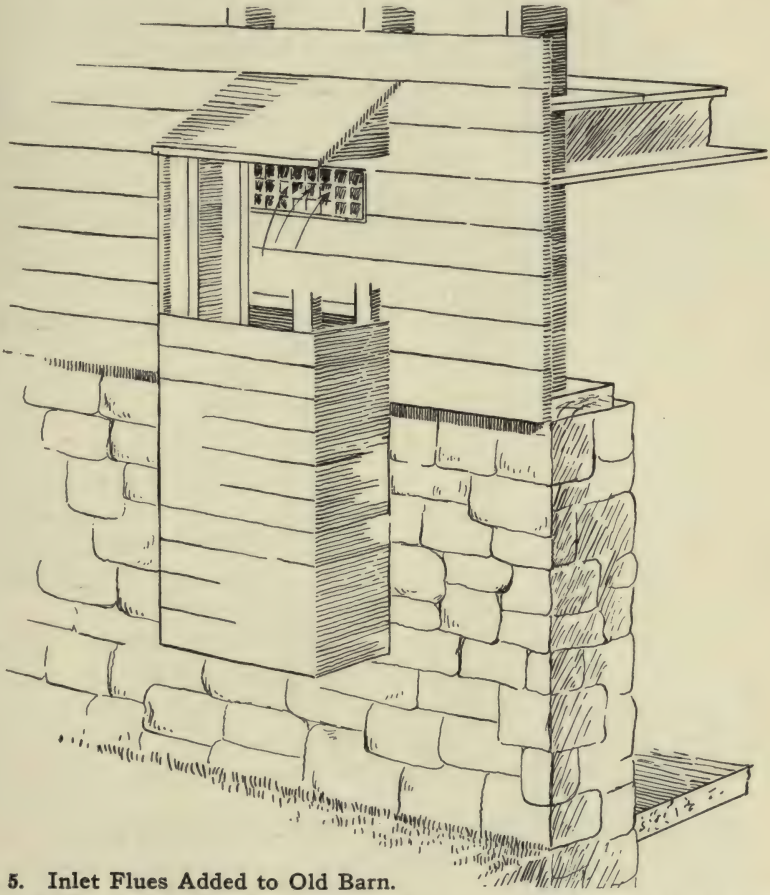


Fig. 5. Inlet Flues Added to Old Barn.
Fresh air inlet flues can be added to any barn with but very little expense.

Windows may be so arranged as to provide ventilation, but in this climate should never take the place of the King system. In case windows are to be used for ventilation they should be hinged at the bottom and open inward from the top. At either side is a galvanized iron shield which prevents air entering at the sides of the window and blowing directly on the cattle.

Flues Must Be Properly Constructed.

Much of the success of the King system of ventilation depends upon the construction of the flues. Figure 6 shows detail of construction of an outlet flue. The cost of such a flue will average 75 cents a foot of length. If made of galvanized iron, the flue should be well insulated, otherwise the moisture passing through the flue will be condensed and fall as water. Insulating a round or square galvanized flue is generally impossible except by a commercial concern. This will increase the cost of installation.

Build Flue the Right Size.

In this system the total area of the outlet flues should practically equal the area of the inlet flues. If the windows and doors are not tight the number of inlet flues should be reduced so that their total area should only equal two-thirds of that of the outlet flues, as there will be enough air entering the cracks to furnish plenty of fresh air.

A convenient size of outlet flue is 18x24 inches or 16x22 inches. In figuring the size of flue the number of animals should be carefully considered. The following data taken from King's Physics of Agriculture will be found to be of service in computing the size of inlet and outlet flues.

Amount of Air Required for Barn Ventilation.

Horses	71	cubic feet an animal a minute.
Cows	59	cubic feet an animal a minute.
Swine	23.2	cubic feet an animal a minute.
Sheep	15.3	cubic feet an animal a minute.
Hens	.52	cubic feet an animal a minute.

Assuming that air travels through a flue from a stable at the rate of 290 to 300 feet a minute, the size of outlets and inlets may be determined as follows:

$$\frac{\text{Total No. of cu. ft. of air required}}{300} \times \underset{\text{in 1 sq. ft.}}{\text{144 sq. in.}} = \underset{\text{sq. in. of inlets or outlets.}}{\text{Total cross-sectional area}}$$

$$\frac{\text{Total cross-sectional areas of outlets}}{\text{No. of outlets}} = \text{Cross-sectional area of each outlet.}$$

$$\frac{\text{Total cross-sectional areas of inlets}}{\text{No. of inlets}} = \text{Cross-sectional area of each inlet.}$$

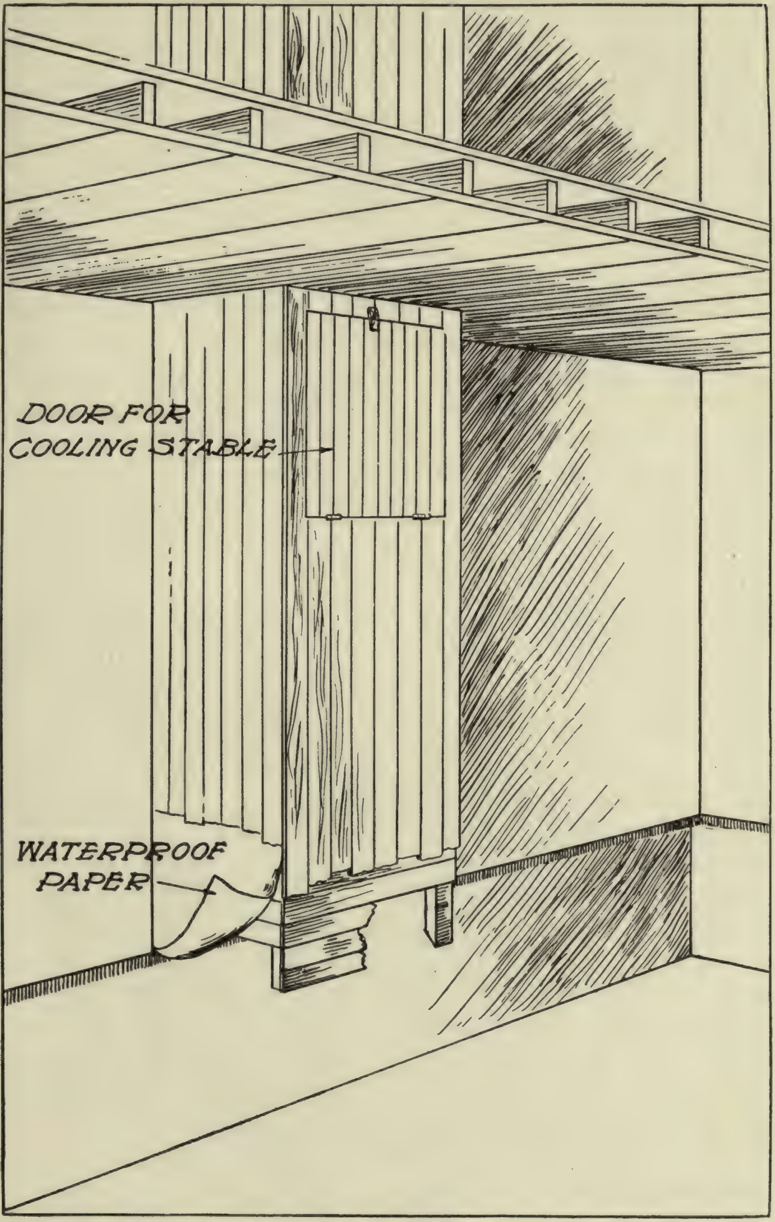


Fig. 6. Much Depends on Outlet Flue.
The success of a ventilating system depends to a considerable extent upon the outlet flue. The opening of the foul air flue is placed one and one-half feet above the floor. In this construction water-proof building paper is placed between the two layers of flooring.

To estimate the amount of air required for a herd of 27 head of cattle and for five horses we would multiply 27, the number of cattle by 59, the number of cubic feet of air required for a cow, which is 1,593. To provide fresh air for the horses multiply 71, which is the number of cubic feet ot air required for one horse, by 5, the number of horses to be kept. This equals 355 cubic feet. The total requirement then would be 1,593 cubic feet for the cattle and 355 for the horses, or a total of 1,948 cubic feet.

In order to get the total cross-sectional area of either outlets or inlets divide 1,948 by 300 (the rate at which air travels a minute in the flues of a stable) and you would have 6.49. Multiplying 6.49 by 144 (the number of square inches in a square foot) would give 934.5, the total cross-sectional area in square inches of inlets or outlets for this barn. Now the total required area 934.5 will be divided by the number of flues to be provided. A sufficient number of inlet flues should be provided so that the fresh air will enter the barn every 10 to 12 feet. This barn being 36x86 feet, the inlet flues spaced at 12 feet intervals would require 18 flues.

To get the area of each inlet divide the total cross-sectional area of inlets by 18 (1,948 ÷ 18 = 52) each flue should have an opening of 52 square inches. A 6x8-inch inlet flue comes nearest to providing this amount.

The total cross-sectional area of the outlets divided by 4 (1,948 ÷ 4 = 234), which is the number of outlets that will remove the foul air from all parts of the barn, gives a total area of 234 square inches for each outlet. This area will be secured in a flue 16x16 inches. The area of the outlet flues should be a little greater than that of the inlets.

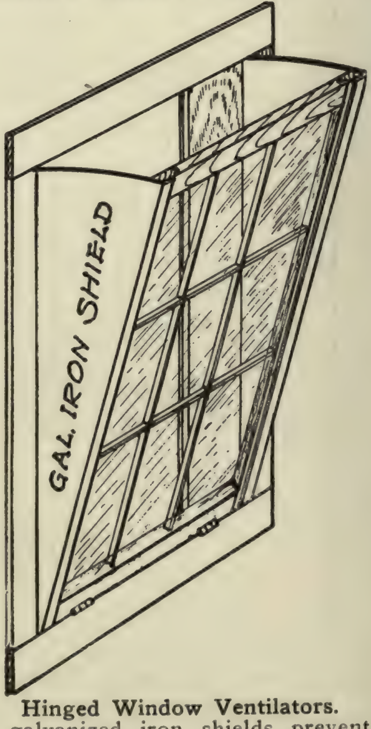


Fig. 7. Hinged Window Ventilators. The galvanized iron shields prevent the air from entering at the sides and blowing directly upon the stock.

Take Care of the Manure.

A dairy barn or a general purpose barn, must be kept clean, as it is a place where human food is produced. The barn floor should be so constructed as not to allow water to pass through it, should be free from cracks and crevices, and reasonably smooth so that it may be cleaned easily. There are two methods practiced in caring for manure. One system is to bed stalls heavily and to clean out the manure every week. The other is to clean the barn daily, hauling directly to the field or storing the manure in a manure pit. The latter system is, from the standpoint of cleanliness, the only satisfactory one.

Supplying Fresh Water.

If a water supply system is available, running water can be piped directly into the barn. There are several companies making satisfactory automatic water systems that require little attention. A common method of watering is that of using the manger as a watering trough. This is satisfactory if proper attention is given to cleanliness.

Convenient Arrangement Saves Work.

The Width to Build. The width of barns is practically standardized at 36 feet. This width is most satisfactory for a double row arrangement of stock. More than two rows of

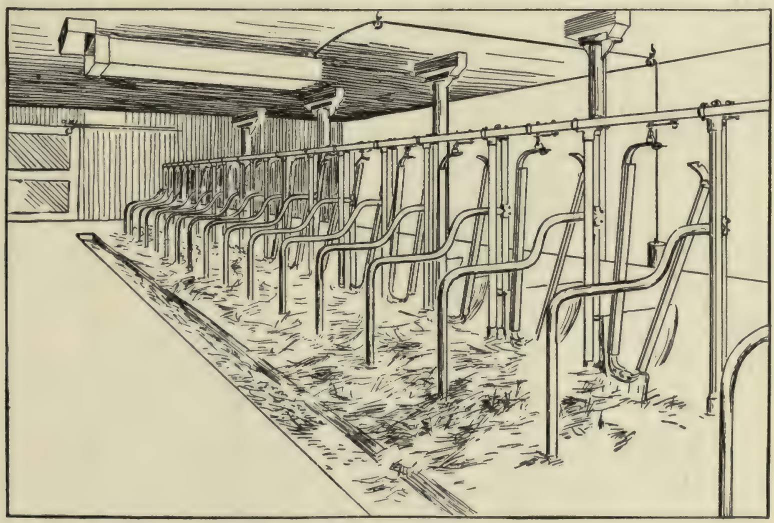


Fig. 8. A Hinged Ventilating Flue.

If the main ventilating flue is connected with the stable by means of a hinged ventilator, this can be drawn out of the way during warm weather. This outlet flue should not be located in center feed alley if the cattle face in.

stock are undesirable on account of the difficulty of lighting and because of the narrow alley which results even in a 40-foot width. A barn 34 feet wide is fairly satisfactory, although the alleys must necessarily be narrower than in a barn 36 feet wide.

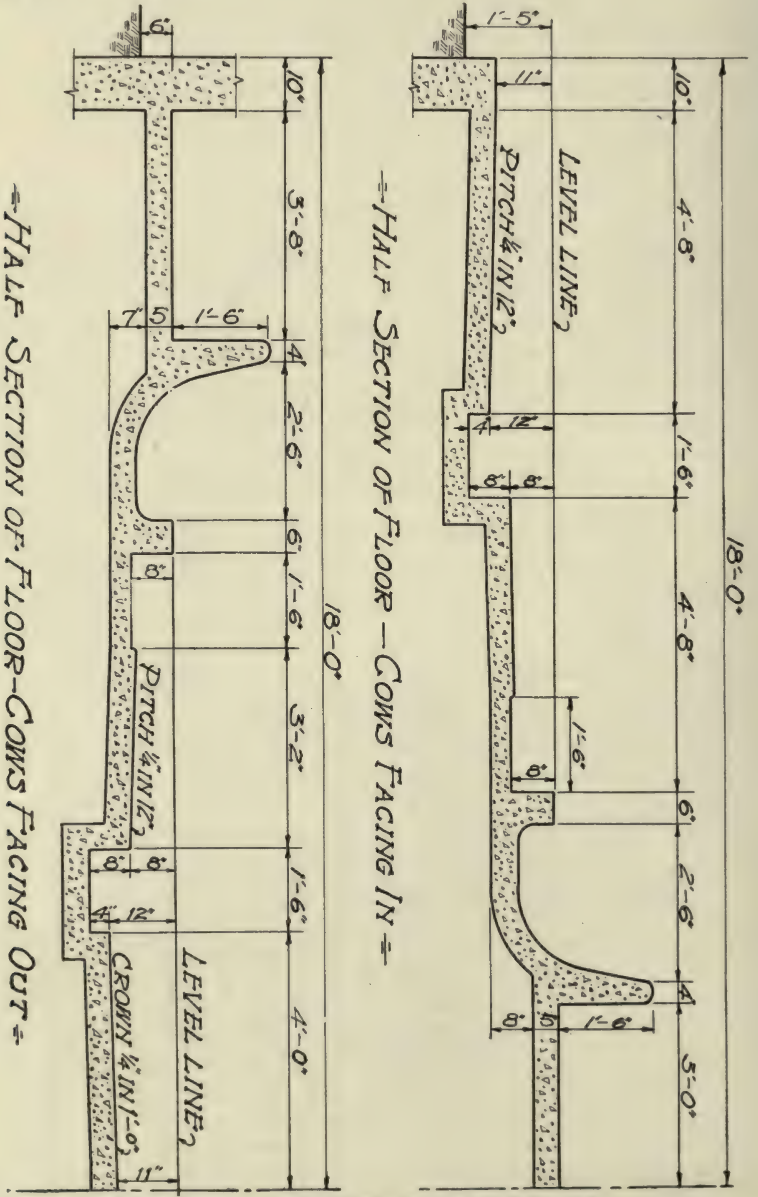


Fig. 9. The Cow Stall Floor Should Be Carefully Planned.
It is important to have the feeding alley, the manger, the stall platform, the gutter, and the litter alley or driveway of good dimensions.

It is difficult to design an interior arrangement of a barn to meet all requirements. The exact dimensions of stalls, mangers, gutters, alleys and driveways are partially a matter of individual opinion. There are, however, some dimensions that should be adopted in the building of every well designed barn.

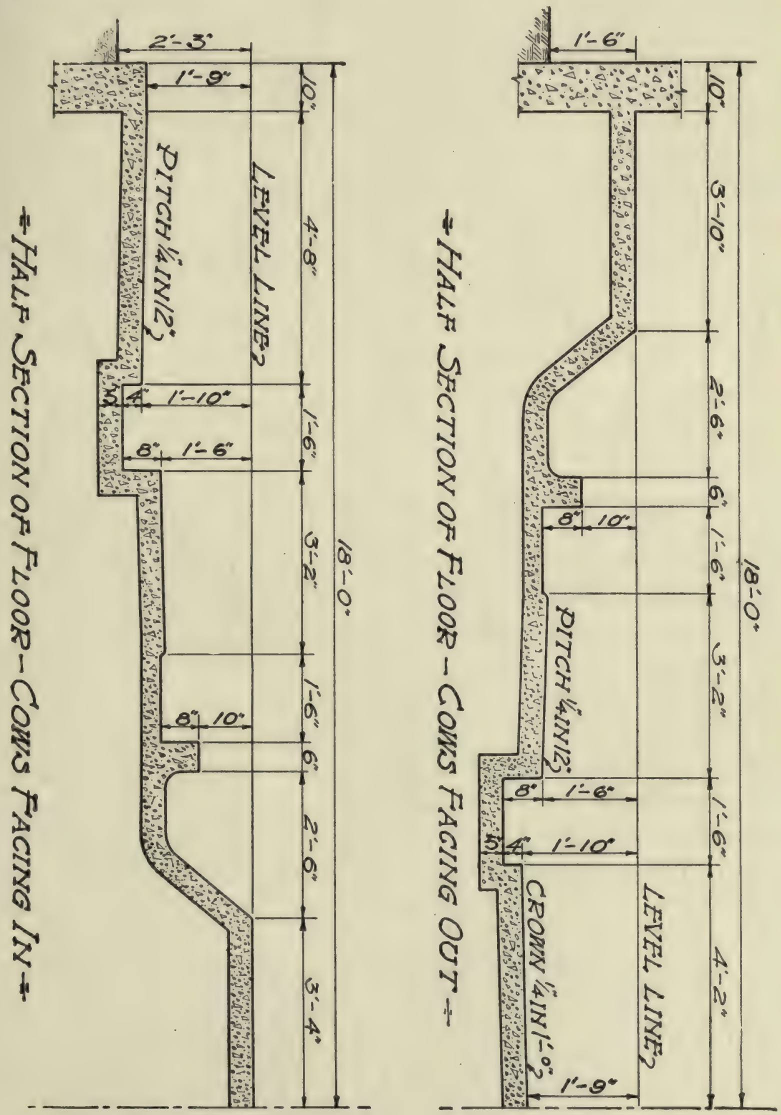


Fig. 10. Feeding Floor Level With Top of Manger.
It is largely a matter of choice whether the feeding alley be raised above or be built upon the level of the stall floor.

The size of stalls varies. The width of mangers is practically standardized at two feet six inches. The average length of a cow stall, from the manger to the edge of the gutter, is four feet eight inches. If it is necessary to vary this length, the stall could be constructed four feet six inches at one end, slanting to five feet or more, at the other. By having the stall of correct length all the manure can be confined to the gutter and the cows kept clean. The width of the stall is standard at three feet six inches. For large cattle, weighing 1,400 to 1,600 pounds, it will probably be necessary to make the stall three feet eight inches wide and five feet long.

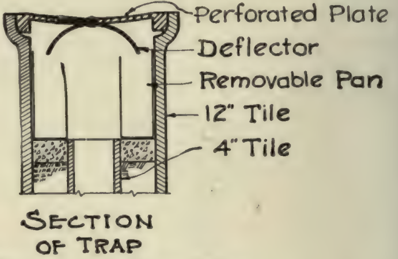


Fig. 11. A Gutter Trap.

To prevent clogging of the drain pipe leading from the stable gutter a homemade trap may be built in.

While the gutter width varies from 14 inches to 20 inches, 18 inches is the most satisfactory width. The depth of the gutter at the edge next to the cow should not be more than eight inches. The depth at the rear of the gutter should not be more than four inches as shown in Figure 10. The gutter should have a slight slope away from the cows. It should also be given a slope of two inches in 50 feet lengthwise of the barn so that the gutter may be flushed easily. This slope is desirable for flushing the liquid manure especially where a cistern is provided. In long barns of more than 50 feet, the slope should be from the ends towards the center. For such a slight slope, the gutters must have a very smooth finish. To prevent clogging of the drain pipe some means should be used to prevent the entrance of chaff and other coarse materials. A home-made trap as shown in Figure 11 will serve this purpose.

Wide Feed Alleys Best.

Feed alleys should be four or more feet in width. Cows have a habit of pushing forward in their stalls which makes it all the more difficult to feed from alleys of less than four feet. Passageways between long rows of stalls or at ends of stalls can be two feet when used largely at milking time to save time in walking around long rows of stanchions.

Shall Cows Be Faced In or Out?

Whether it is better to face cows out from, or toward a center aisle is an open question; good arguments can be made in favor of either arrangement. One of the chief advantages for having the herd face the center aisle is that this arrangement provides a certain feeding alley. It, of course, is more convenient to feed from one alley, especially if feeding ensilage. Careful feeding is very necessary to successful dairying and as cattle are fed two or three times a day this point deserves considerable attention. Then, again, when the cows are faced in there is no danger of the direct sunlight affecting the cow's eyes. The arrangement places the milkers nearest the light so that they can see that the cow's udders are clean. Cleaning out the manure is as easy, if a litter carrier is provided, as driving through the barn between two rows of cows. A feed carrier can be installed running between the two rows of cattle and be used to carry feed to various parts of the barn.

The advantages of having the cattle face out are: first, less alley space is required (when cattle face the center aisle the back walks must be wide or the walls will be spattered with manure); second, a manure spreader can be loaded in the barn and hauled directly to the field, thereby saving handling the manure twice; third, sale cattle can be shown to better advantage when facing out from the center and it is claimed by some that it is easier to get cows in and out of the barn, with less danger of crowding.

Stall Floors Should Be Sanitary.

Floors of nothing but untreated wood are not advised for dairy barns. A good concrete foundation, well drained, with a wood overlay, or creosoted wood block, is entirely satisfactory. In constructing the wood overlay (Figure 12) the boards should be laid lengthwise of the stall. It should be made so as to be easily removed, thus permitting cleansing. A concrete floor, to be satisfactory, must be finished with a wood trowel which will leave the surface rough enough to prevent the cows from slipping and also to make it possible to keep bedding on the floor.

Cork brick are quite extensively used for flooring and are very satisfactory, but more expensive than concrete or wood. These are sanitary and are not cold, as is the case with concrete. They will last much longer than the ordinary untreated wood floor.

Wood blocks treated with creosote and laid on a concrete foundation are cheap and serviceable for cow stall

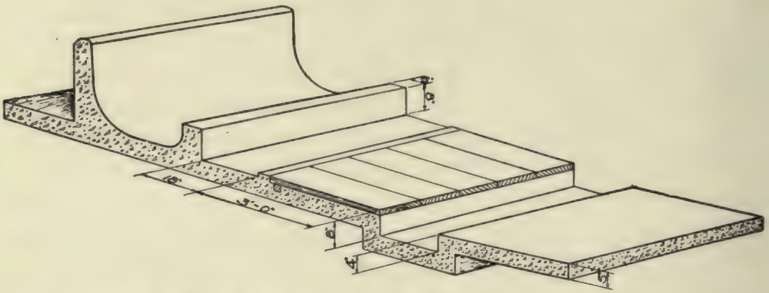


Fig. 12. A Wood Overlay for the Stall Floor.
A concrete floor should be covered with bedding or a wood overlay. It can be kept in a sanitary condition.

floors. One living near a city where a wood block pavement is being constructed can usually secure the blocks either from the contractor or from the city, or from creosoting companies.

Have Feed Room Convenient.

In a dairy barn the feed should be stored in a convenient place at either end of the feed alley. The feed-bin is usually placed on the second floor and should be connected directly with the feed room by means of a chute. This feed room should be close to, or a part of, the silo room and so arranged that it may be entirely shut off from the main part of the barn.

Provide a Bull Pen and Maternity Stalls.

A bull pen and one or more maternity stalls are needed on a dairy or stock farm. The maternity stalls should be approximately 10x10 feet and be provided with an abundance of light. A convenient arrangement for the bull stall is shown in Figure 13. It provides for two outside doors, one for the bull to come in through, the other to go out. Such an arrangement makes it unnecessary to enter the stall, the exit door can be opened from the outside, the bull untied from the front and allowed to go out and exercise.

It will be noticed that in this arrangement the bull cannot turn around and that there is no necessity of getting into the pen either to turn him out or to tie him.

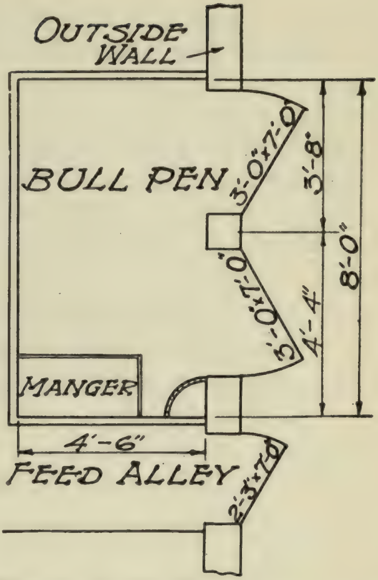


Fig. 13. Safety First.
This pen is so arranged that the attendant can care for the bull without entering the stall.

Separate Milk Room Preferable

A milk room should be located near, but preferably not inside, the dairy barn. The entrance to the milk room, it is often urged, should be gained from the barn only after going entirely out of the stable. Milk, of course, is easily contaminated by odors. This room could be conveniently located underneath the barn bridge or near the entrance of the barn. It is exceedingly important that the gas engine for operating the separator be outside the milk room. Gas contaminates milk and the odor can be detected in the butter.

Details of Construction

Too many of us when thinking of building a barn start at the wrong end. A fixed dimension is generally considered and then the problem is to get all the stock on the farm into this building. A better method of arriving at the size of a barn is to consider the number of cattle or horses to be put into the building. Thirty-six feet seems to be the standard generally adopted for the width of a barn.

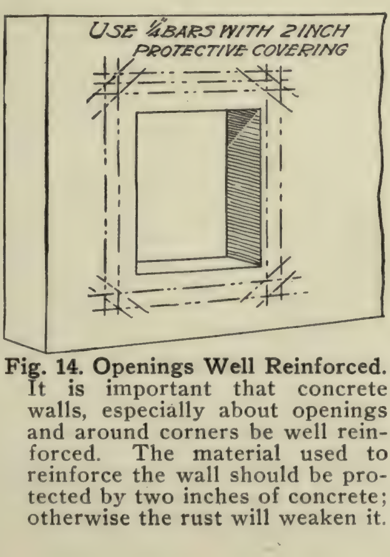


Fig. 14. Openings Well Reinforced.
It is important that concrete walls, especially about openings and around corners be well reinforced. The material used to reinforce the wall should be protected by two inches of concrete; otherwise the rust will weaken it.

Walls are often built of stone or concrete. If of solid concrete they should be 10 to 12 inches thick and well reinforced around doorways and windows. If the walls are built of stone they are usually 18 to 24 inches thick.

An all fireproof barn is of doubtful value. The hay and straw, stored in the haymow, are of such a character that the great heat in case of fire would be likely to cause the solid wall or roof to crack on the explosion of the gas generated from the fire. There is no doubt, however, of the value of a fireproof basement. Such a construction is within the reach of any man who can afford to put $4,000 into a barn.

Protect Against Lightning.

Barns are less likely to be damaged by lightning if rods are used. Investigations by the farmers' mutual fire insurance companies prove that the damage to rodded barns by lightning is low in comparison with the damage to unrodded barns. Many reports on the use of the lightning rod show that it is from 80 to 99 per cent efficient on farm buildings.

Iron and copper or combinations of the two are the commercial materials available for lightning rods. Both of these materials give equal satisfaction. The important points in selecting and installing the lightning rod are:

(1) Do not use insulators. Fasten the rod directly to the building; (2) The rod should be made of a material which will resist the action of weather and soil; (3) Joints must be rigid and permanent. Screw joints are considered best; (4) Earth connections should be made to a point of permanent moisture; (5) Terminals must be rigid, well supported and should be made of solid material; (6) Terminals are placed at distances of about 25 feet, on ventilators, silos and chimneys; (7) All metallic parts on the surface of the barn should be connected with the rod. The lower inside end should be connected with the earth. For example, a wind mill placed on top the barn should be connected with the lightning rods on the outside and grounded to the earth on the inside.

A barn, in fact all farm buildings, are inadequately protected from fire. Some type of a water supply system which would also furnish a supply for the house ought to be provided for fire protection. A tank placed in the haymow or a pressure tank located in a separate building would be cheap fire insurance.

Strength Important in Barn Framing.

The plank frame type of construction is most generally used at the present time. The old timber frame type of construction is too expensive and large timbers are difficult to secure at the local lumber yards. Two inches is the thickest material used in plank frame type of construction. It is a distinct advantage to use the plank frame type of construction for it saves in the cost of lumber, is more easily handled, takes less time to construct, and requires less skilled labor in framing the barn.

Either horizontal or vertical siding can be used. Drop siding or shiplap is ordinarily used for horizontal siding and 1x10-inch boards with three-inch battens placed over the cracks for vertical siding. It is best to ceil the inside of the basement with flooring or ceiling.

More Hay Room Under a Gambrel Roof.

There are two general types of barn roofs, the gable and gambrel. Many times the latter is called incorrectly the "hip" roof. The advantage of the gambrel over the gable roof is that increased hay room can be secured without building the barn any higher either at the plate or ridge.

The height of the gambrel roof should be equal to the width of half the building. The first rafter should have a rise of one-third the width of the building and a run of one-sixth. The second should have a run of one-third the width of the building and a rise of one-sixth. Then in the case of a 36-foot barn the lower rafter would have a rise of 12 feet and a run of 6 feet, the second rafter a run of 12 feet and a rise of 6 feet.

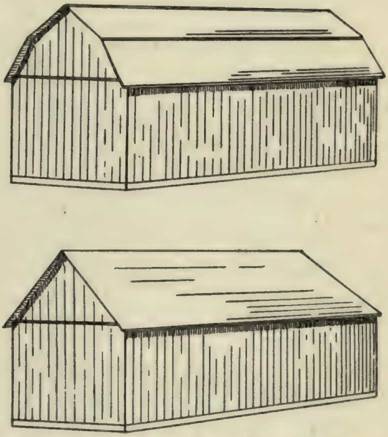


Fig. 15. Gambrel and Gable Roofs. The hay mow is increased in size in a gambrel roof barn without increasing the height of the roof at the plate or ridge.

End Brace Adds Strength.

The end brace shown in Figure 16 is designed to prevent any end racking of the barn as well as to prevent the end of the barn from springing. Many plank frame barns constructed without this brace are likely to spring out at the end, in some instances as far as from two to six inches. As there is no other truss work or ties bracing the end of the barn, it is very desirable that the end brace be built in a barn of the plank frame type of construction.

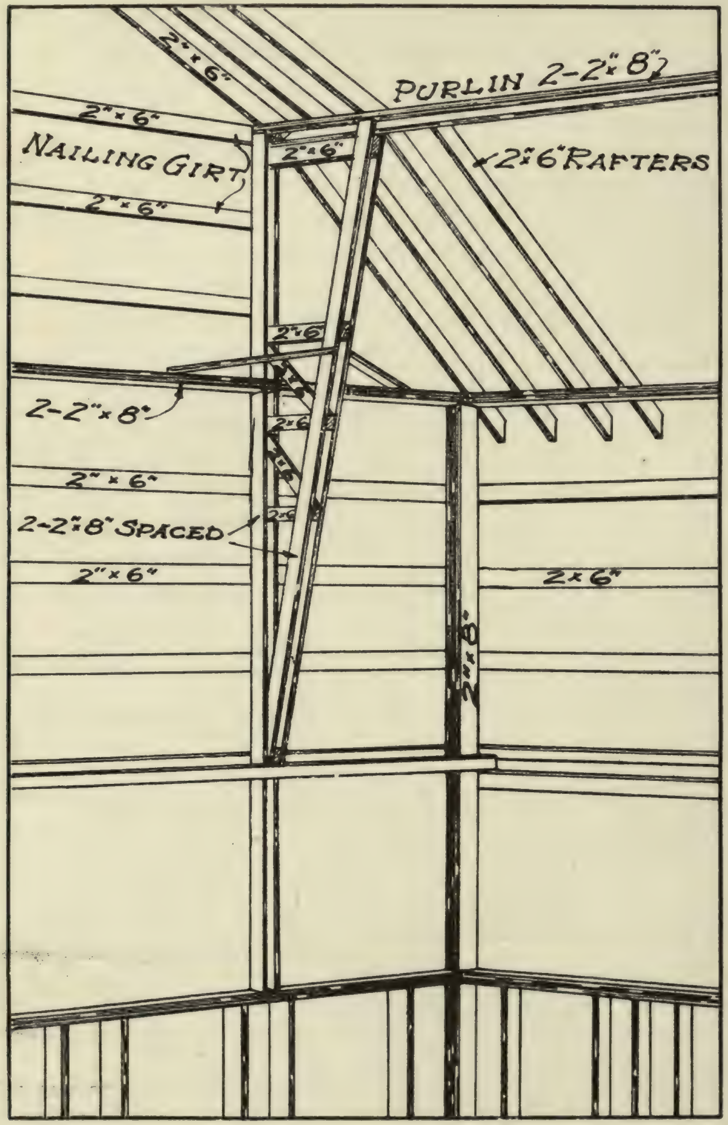


Fig. 16. The End Brace Adds Strength.
In some plank frame barns the ends often bulge out. The end brace prevents this at a very slight additional cost.

Walls of Concrete Require a Good Form.

A form for building a concrete wall requires good bracing and judicious spacing of braces. Figure 17 shows the detail construction of a form for building from a three to a nine-foot concrete wall.

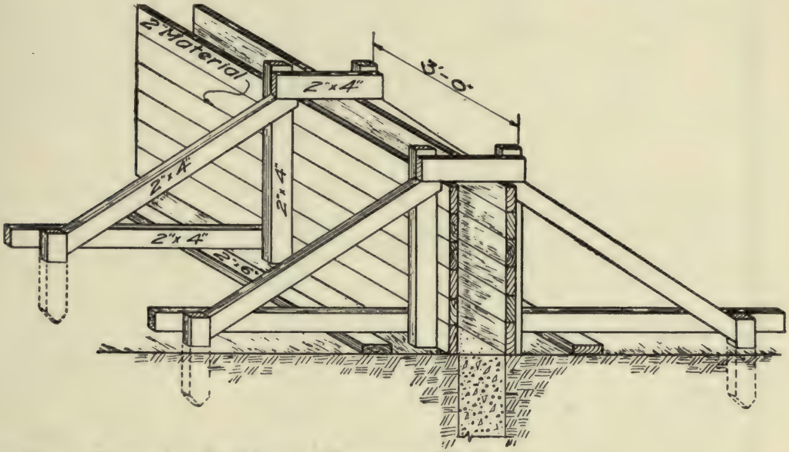


Fig. 17. A Form for Building a Concrete Wall.
In building a concrete wall much depends upon having the bracing in the form of sufficient strength and properly spaced.

Available Barn Plans.

Complete sets of blue prints and bills of material for the barns illustrated on pages 26 to 37 may be procured from the National Lumber Manufacturers Association, Chicago. Plans No. 1, 2, 3 and 4 are $1.00 per set, and plans No. 5 and 6 are 50 cents. In ordering be sure to specify the number of the plan desired, and in plans Nos. 1, 2, 3 and 4 state whether you desire to use drop siding or stock boards running up and down. These working drawings which can be furnished at the above prices are identical with the small illustrations, and consist of cross-sections or floor plans showing all dimension and framing details, together with elevation plans.

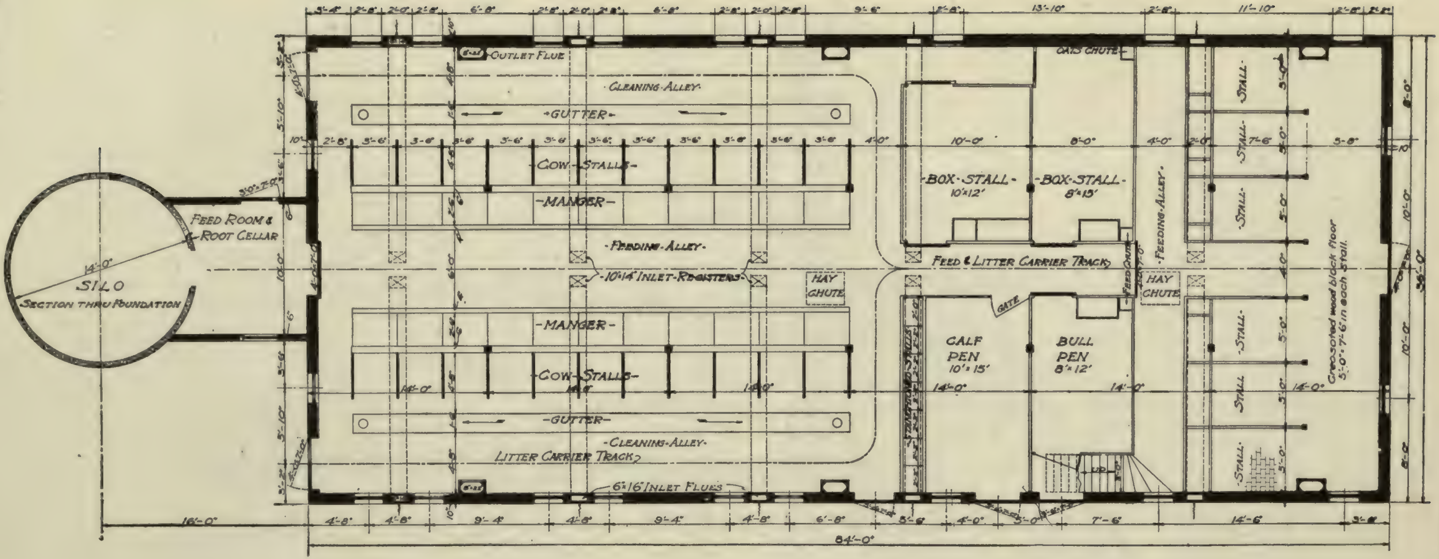


Fig. 18. Floor Plan of General Purpose Barn (Plan No. 1).

This general purpose barn is 36 feet wide and 84 feet long and is planned to accommodate 22 head of cattle and six horses. It also contains a calf pen, a bull pen and two box stalls. The cows face in and the silo is placed at the end of the central feeding alley. The horse barn is separated from the cow barn by sliding doors. The barn loft is divided into six bents of 14 feet each. Hay is elevated into the barn from the outside and feed bins are provided on the second floor. The feed room and silage room are combined. A root cellar is provided just below the feed room.

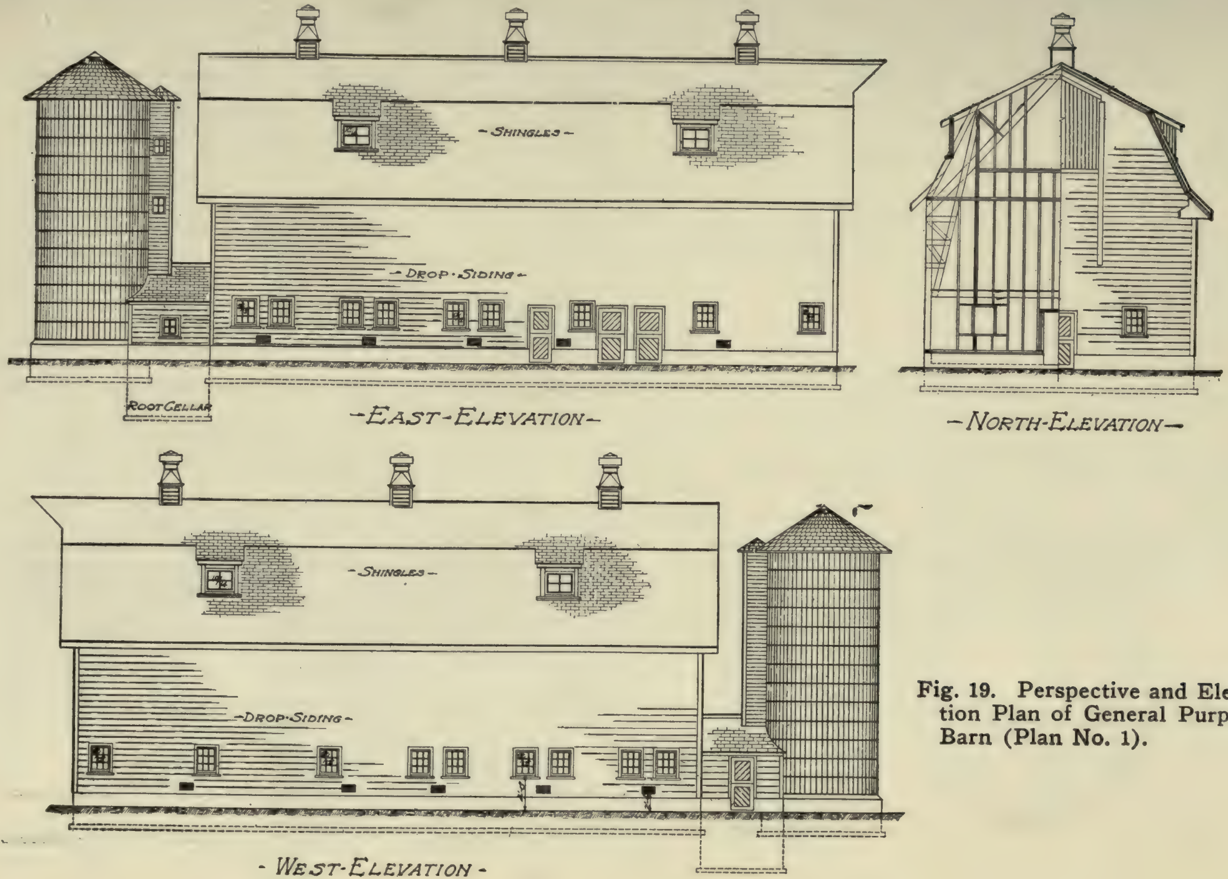
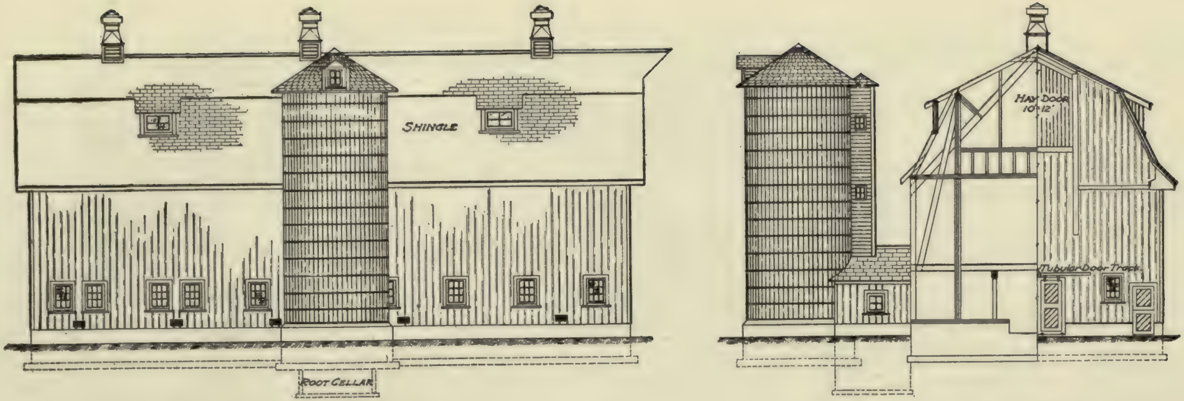
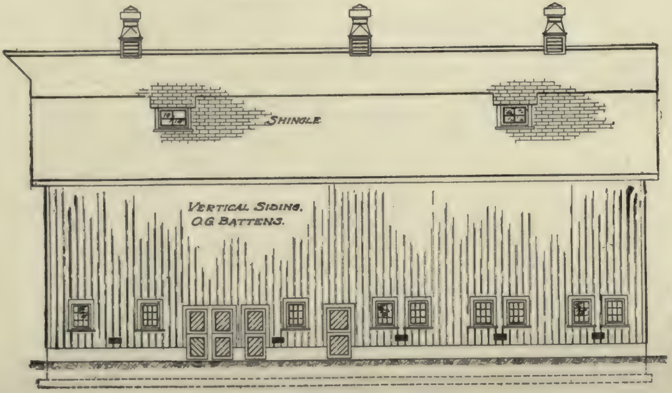


Fig. 19. Perspective and Elevation Plan of General Purpose Barn (Plan No. 1).



-EAST-ELEVATION-

-NORTH-ELEVATION-



-WEST-ELEVATION-

Fig. 20. **Elevation and Perspective of General Purpose Barn (Plan No. 2).**

In this general purpose barn, which is 36 feet wide and 86 feet long, the cows face out. In all other respects it is essentially the same as Plan No. 1. The silo has been placed at one side of barn in order to permit a driveway through the center.

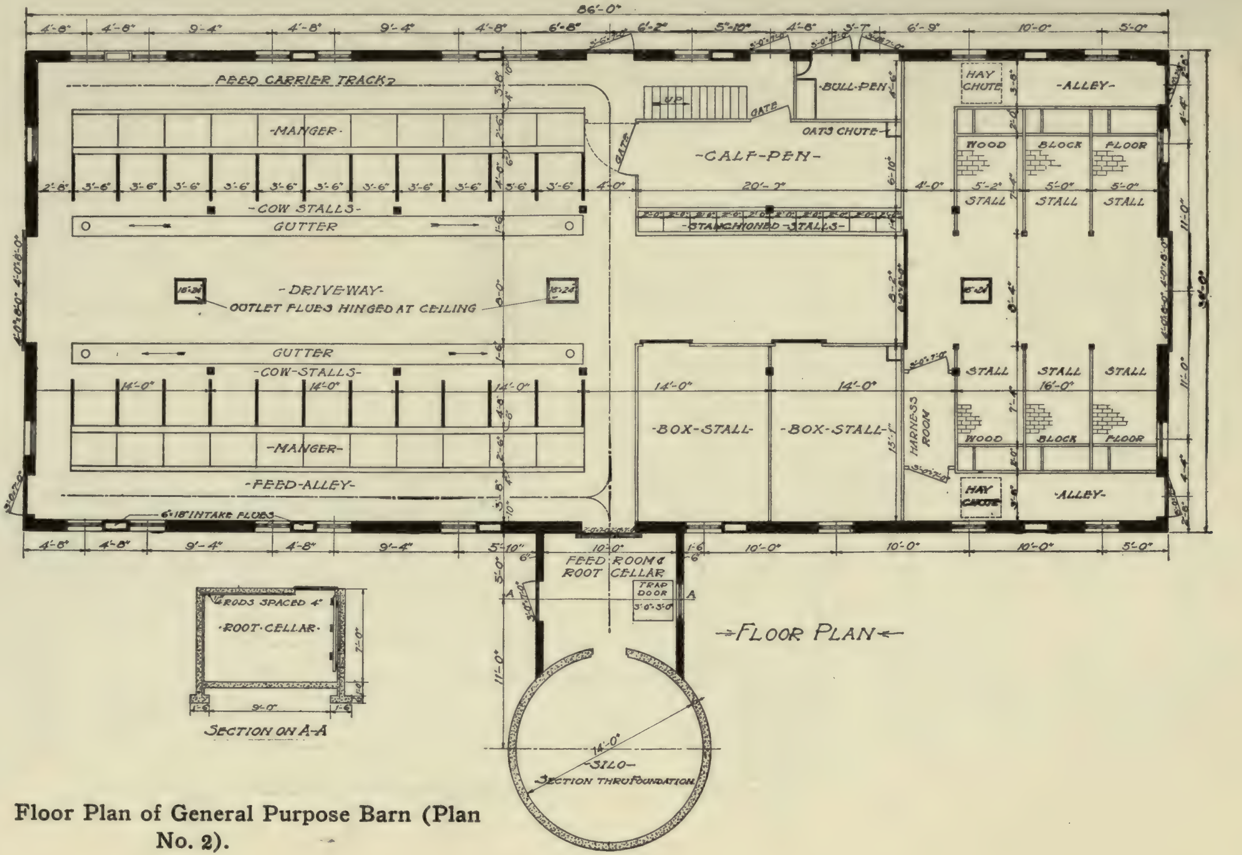


Fig. 21. Floor Plan of General Purpose Barn (Plan No. 2).

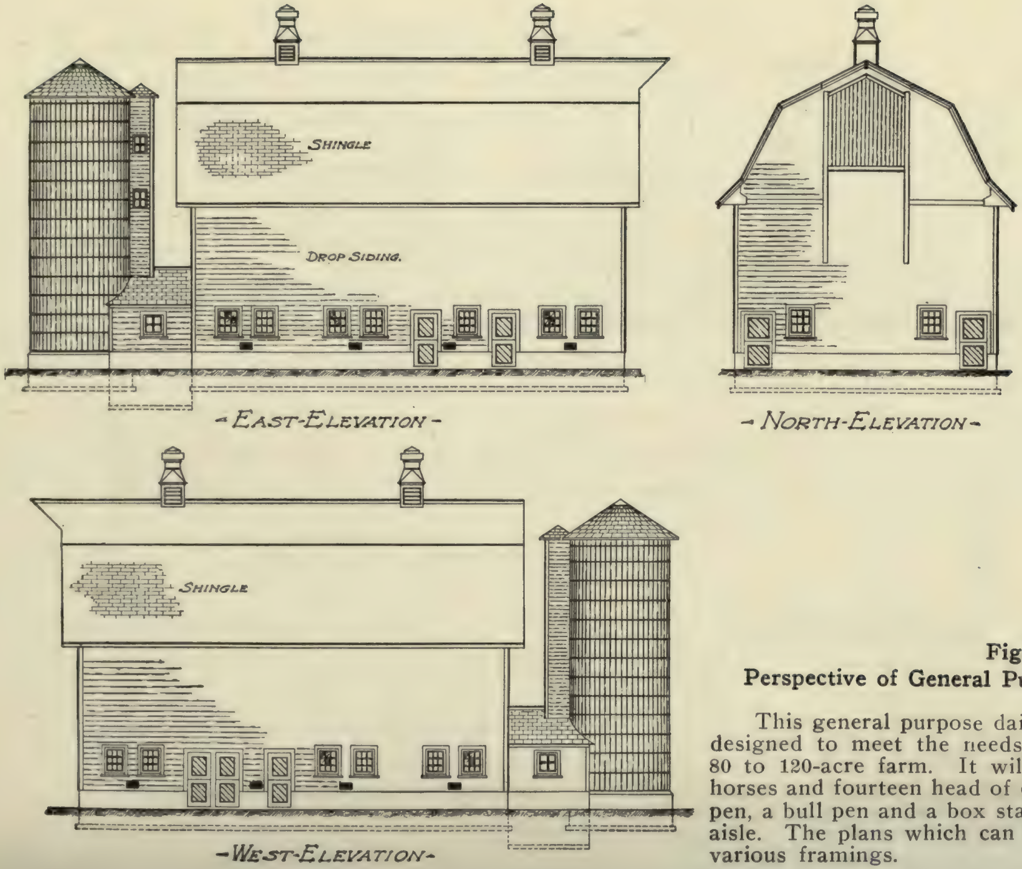


Fig. 22.
Perspective of General Purpose Barn (Plan No. 3.)

This general purpose dairy barn (34 feet x 56 feet) is designed to meet the needs of the farmer on about an 80 to 120-acre farm. It will accommodate four head of horses and fourteen head of cattle. It also contains a calf pen, a bull pen and a box stall. The cows face the center aisle. The plans which can be furnished show details of various framings.

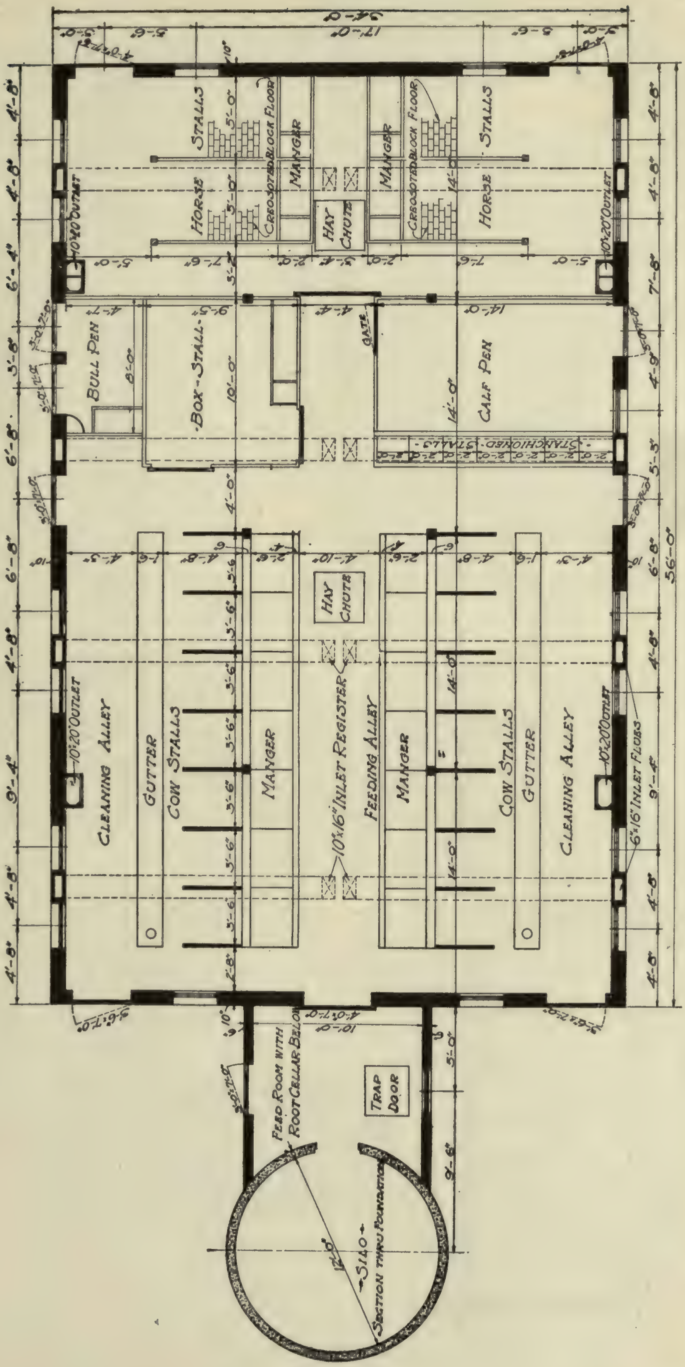


Fig. 23. Floor Plan of General Purpose Barn (Plan No. 3).

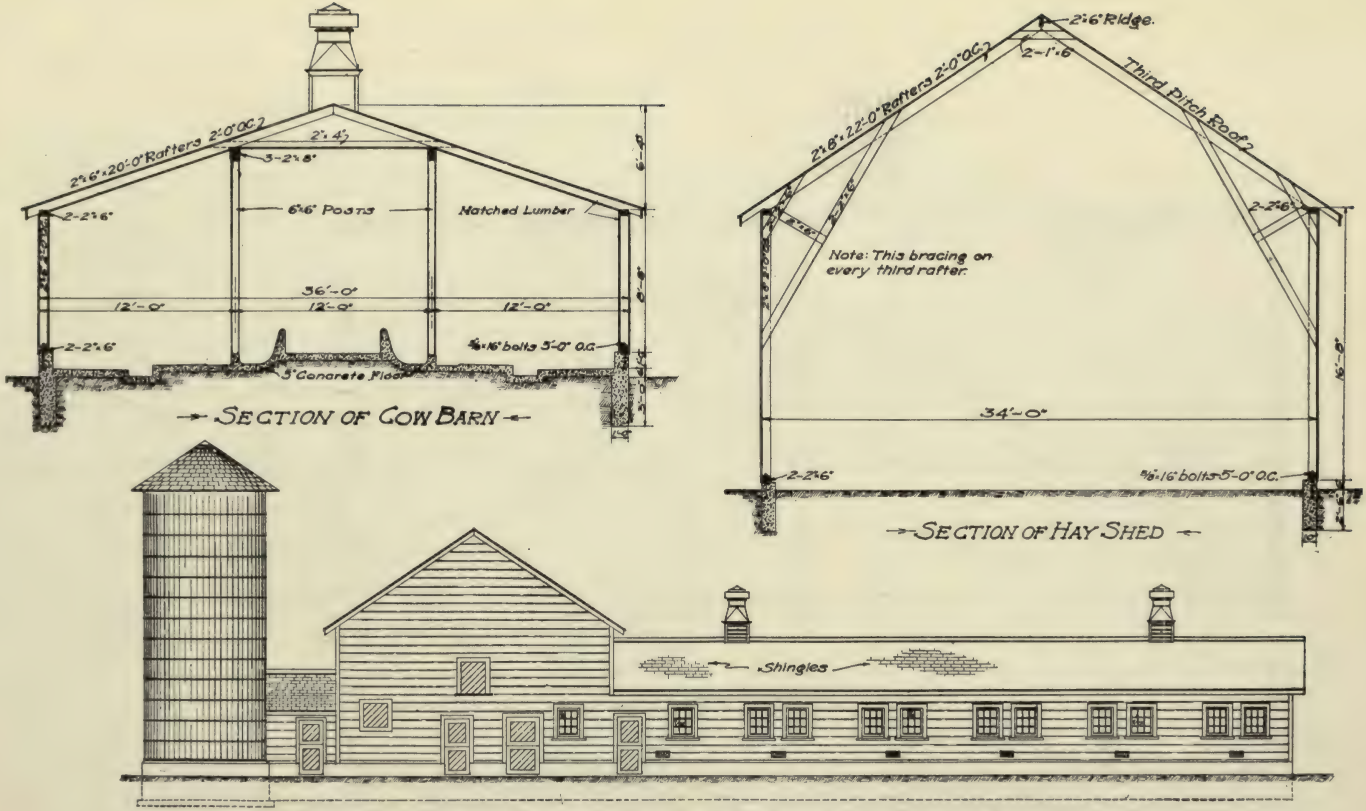
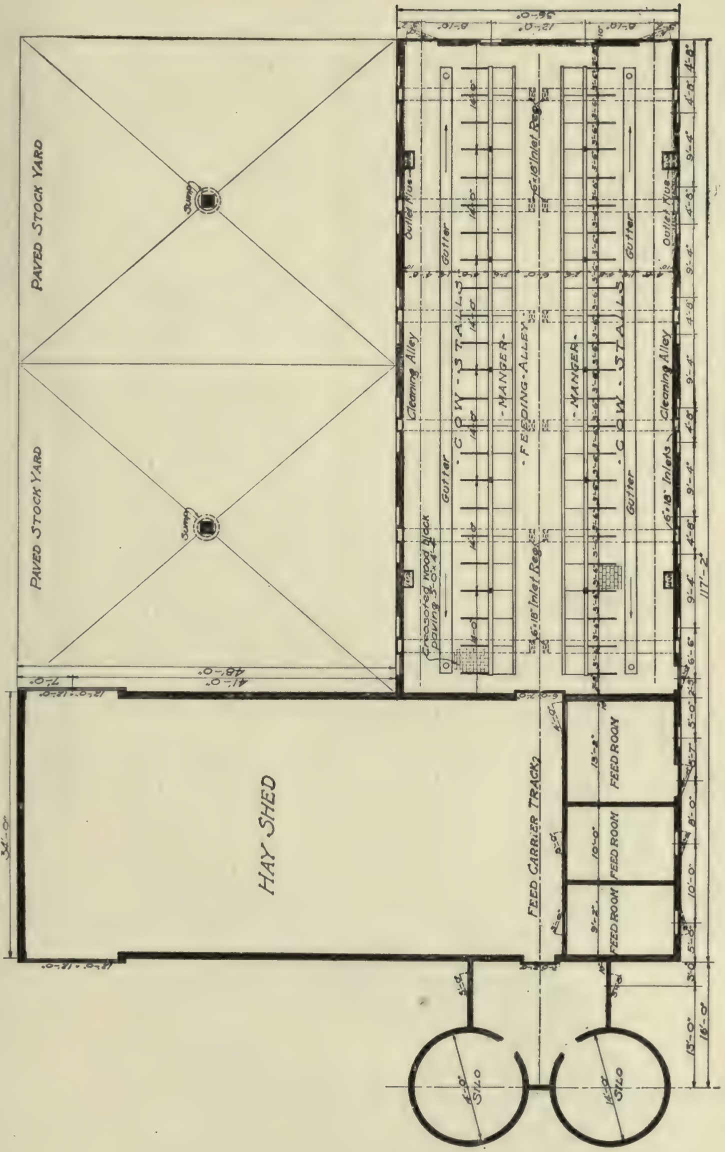


Fig. 24. Perspective and Elevation Plan of Dairy Barn (Plan No. 4).

This shows a one-story type of barn with hay shed and feed room placed on the north side. The floor plan provides for 44 cows, and except that no room for horses is provided is practically the same, so far as arrangement is concerned, as that of No. 1. This type of construction is somewhat cheaper than the regular two-story barn and permits of expansion at a lower cost without the waste storage space.



- FLOOR - PLAN -

Fig. 25. Floor Plan of Dairy Barn (Plan No. 4).

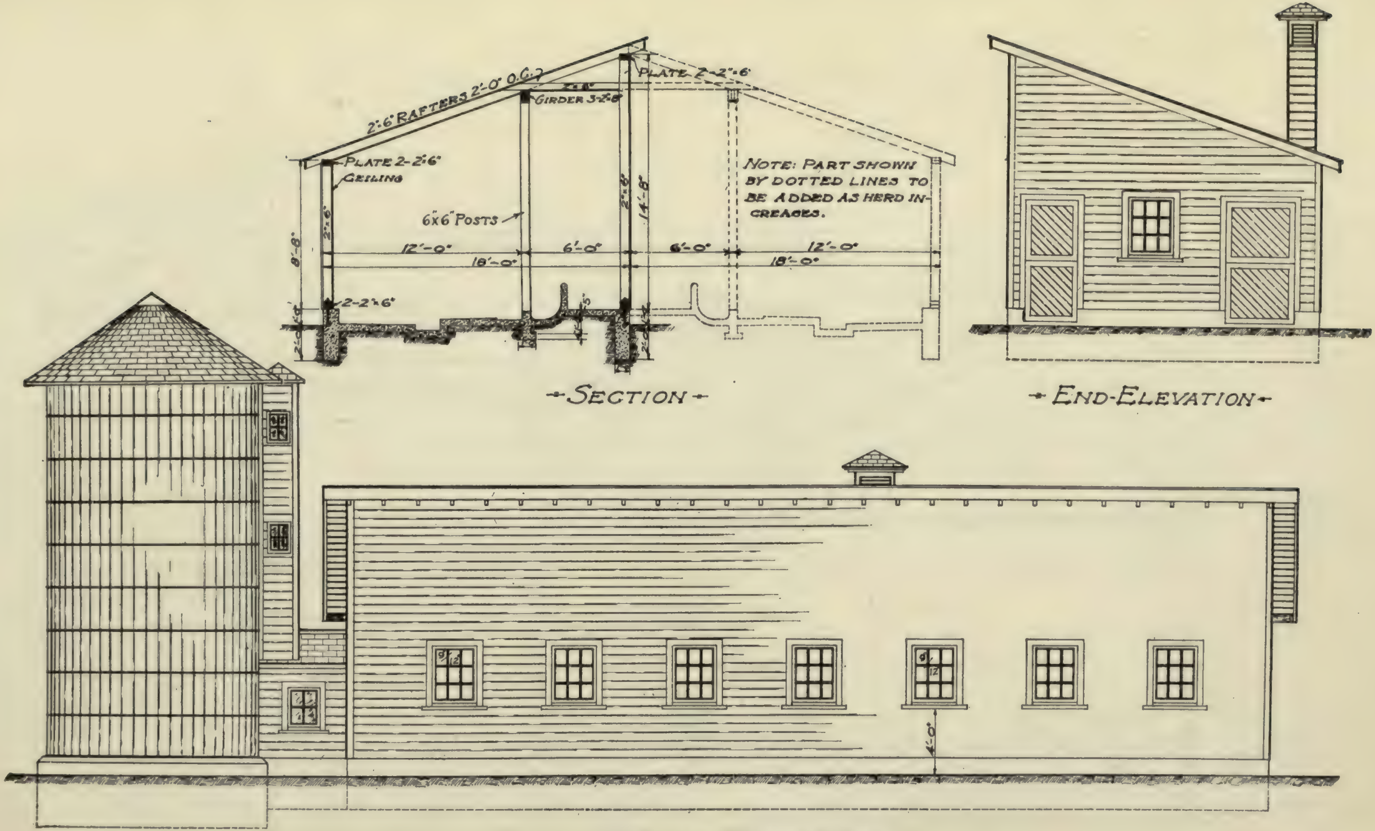


Fig. 26. Perspective and Elevation Plan of Pioneer Barn (Plan No. 5).

This pioneer barn is 18 feet wide and 56 feet long, and is designed for the settler farmer. It is planned so that the barn can be added to easily and eventually be 36 feet wide and hold just double the present capacity of eight cows, three single horse stalls, one double stall and one box stall.

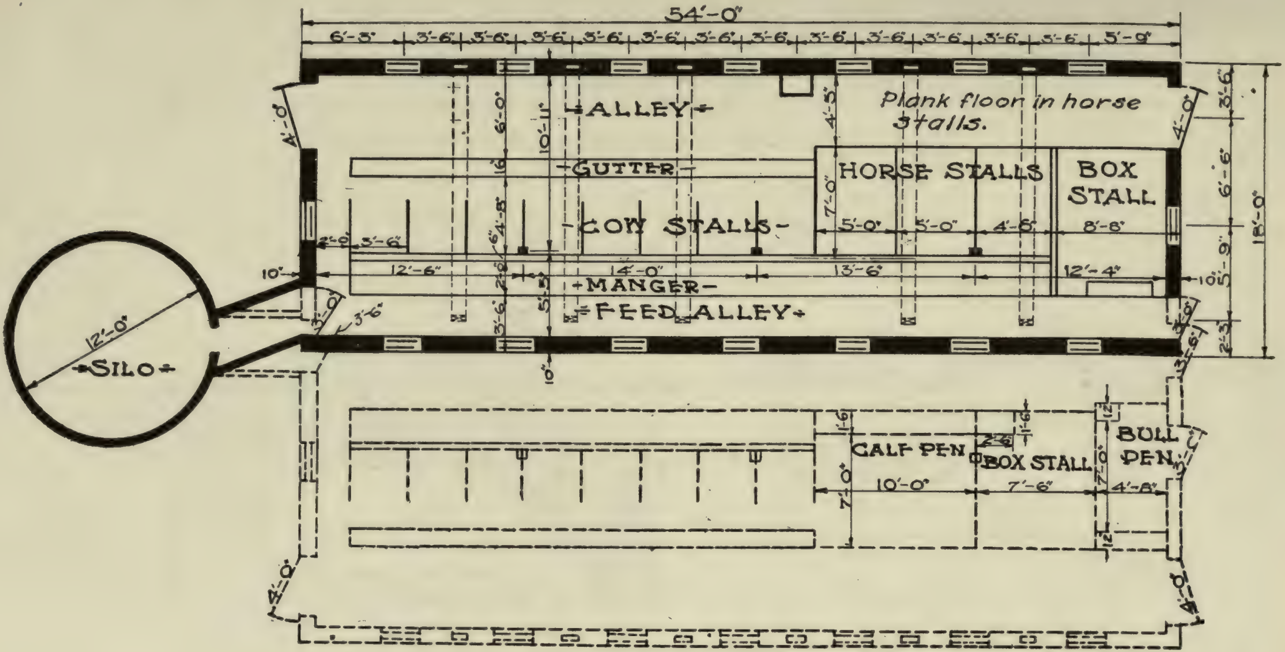
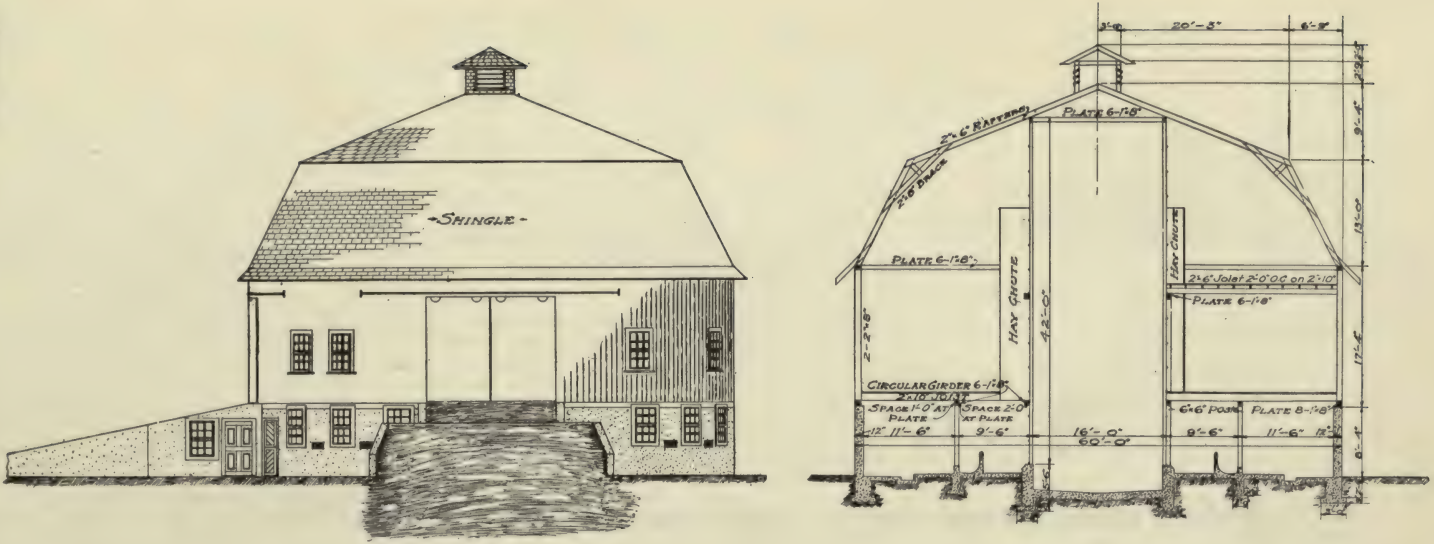


Fig. 27. Floor Plan of Pioneer Barn (Plan No. 5).

The dashed lines indicate proposed addition. The King system of ventilation used has intake flues 6 feet by 10 feet with out-take flues 14 feet by 22 feet. The windows are 9 feet by 12 feet—9 light.



-ELEVATION-

-CROSS-SECTION-

Fig. 28. Elevation Plan of Round Barn (Plan No. 6).

This round barn, 60 feet in diameter, is designed to meet the needs of the strictly dairy farmer. It will accommodate 34 cows. Space is most economically used in a round barn by not trying to house young stock or horses. The second floor space is provided for feed and space for silage cutter. A driveway leads to this floor for unloading hay.

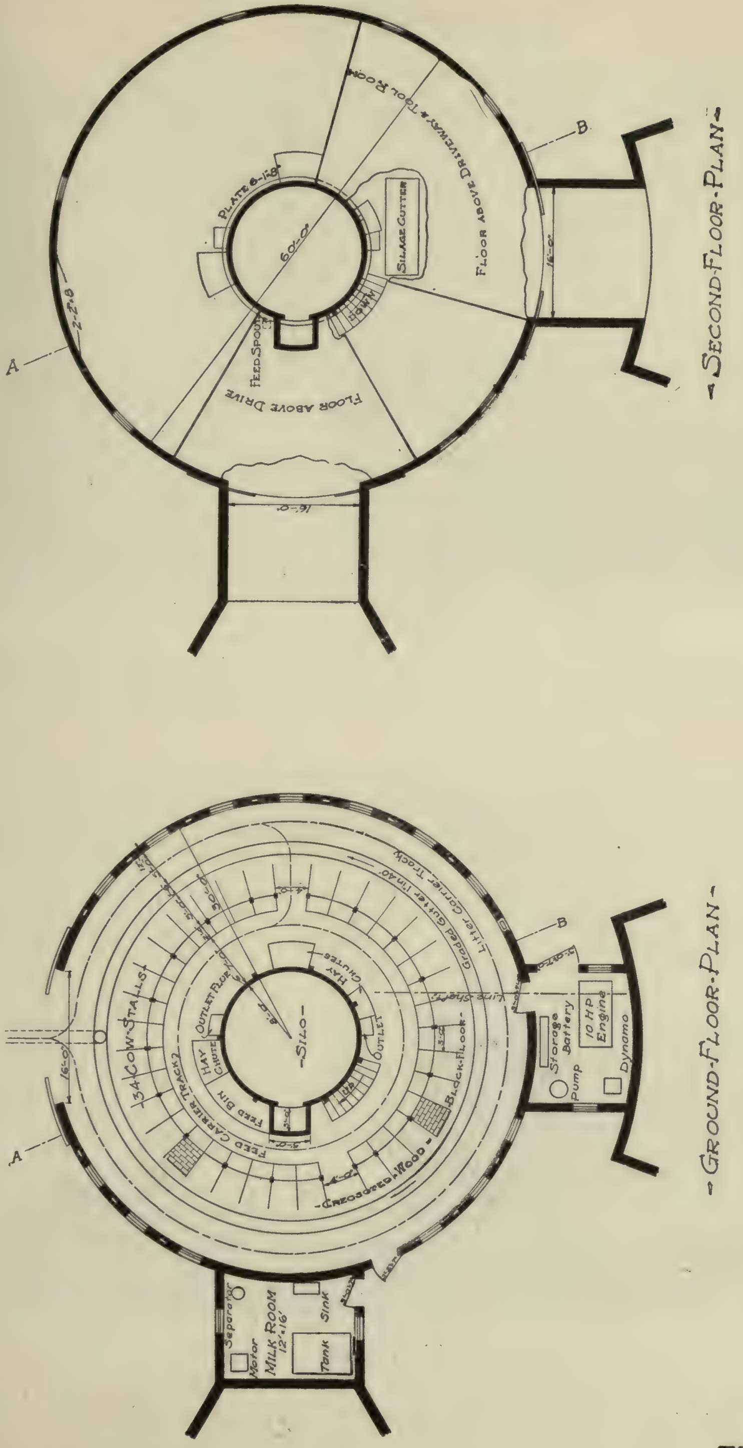


Fig. 29. Floor Plan of Round Barn (Plan No. 6).

A COMPARISON

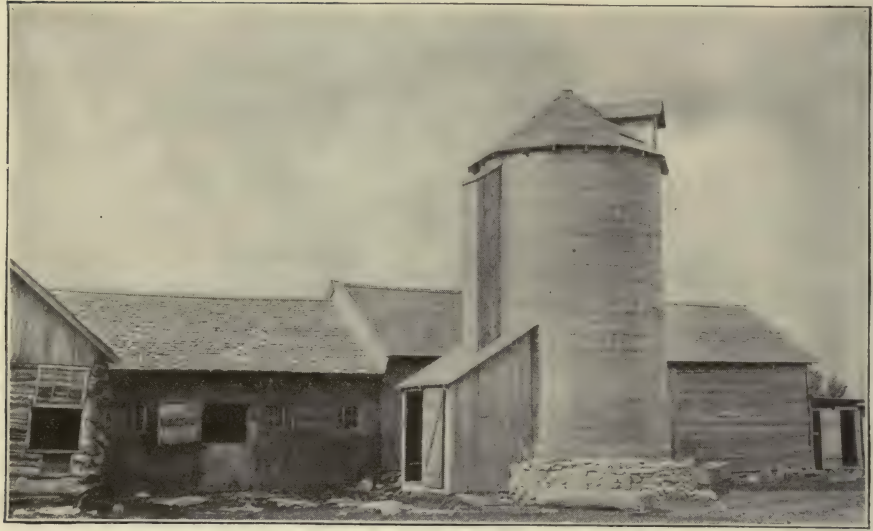


Fig. 30. A New Barn Badly Needed.

The "Kno-Freeze" silo is the only modern feature. Three generations of barns are seen, starting at the old log barn at the left. The fourth should be a new and better type.

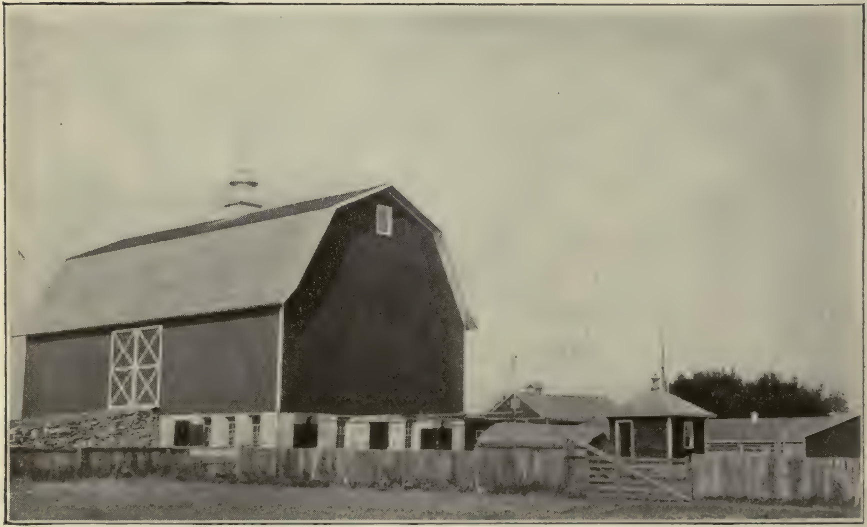


Fig. 31. The Barn of Your Needs and Dreams.

A good farm building group. The silos are hidden behind the barn; the implement shed is seen in the right background.

Wood "Where Best"

The legitimate use of lumber where it is best, or by proper selection or treatment, can be made to serve economically and safely, is the aim of the lumbermen in publishing a series of bulletins on Farm Structures. Wood has for so long been the most widely used building material that its availability and importance have either been taken for granted or lost sight of. It is helpful to review the outstanding features of the present situation:

Wood remains the most universal, most adaptable building material in the world.

The supply is ample for all requirements, and the kinds and grades best suited for all purposes are obtainable everywhere.

In cost it remains one of the cheapest materials.

It is the lightest building material known, and the strongest, weight for weight.

Its qualities are known; it is easy to work; it can be cut and shaped by any one into a myriad uses required for the shelter and comfort of man.

There is no material more beautiful in appearance, more susceptible to artistic finish, nor which is as productive of sentiment and satisfaction for home building.

Wood is a non-conductor of heat,—cool in summer and warm in winter.

The relative qualities of durability, serviceability and workability should be considered in selecting wood for homes and farm builders. **Consult the local lumber dealer.** His knowledge and advice will assure cheaper, more stable buildings.

Except where naturally durable woods are available, a preservative treatment will prove economical for timber exposed to moisture and decay, as sills, basement flooring, fence posts, and in similar situations.

Other Farm Bulletins.

Other Bulletins in this and other series are upon:

Swine Houses	**Implement Sheds**
Garages	**Ice Houses**
Poultry Houses	**Silos**
Farm Residences	**Grain Storage Buildings**

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10

Timber For Structural Purposes

(In Its Broad Application to All Wood Construction)

By

E. A. STERLING

Price, Twenty-five Cents

Published by the
ENGINEERING BUREAU
The National Lumber Manufacturers Association
Chicago, Illinois

January, 1916

General Series No. 7 **Second Edition, November, 1916**

"There's a wood for every need"

Engineering Bulletin No. 1 **November, 1916, Edition**

Timber for Structural Purposes

By E. A. Sterling

Announcement The National Lumber Manufacturers Association, through its Engineering Bureau, is preparing a series of technical publications on structural timber. The word "timber," in this case, is interpreted in its broadest application to all wood products used in construction. These bulletins will be available to all who are interested in standard and economical wood construction. The possibilities and advantages of lumber in modern structures, as well as its limitations, will be fully and frankly outlined, and reliable information as to strength, durability, and other characteristics, presented. Supplementing the information on the qualities of timber as a building material, details of proper design, working drawings, new developments, and similar data will be published. Modern wood construction in its many engineering phases will be presented on its own merits, with prejudice towards no other building material. Many materials are embodied in the best designed structures, each with individual merits and special fitness for the purpose.

Service for Architects, Engineers and Builders Where wood products are better or as good, or by proper treatment can be made equal to any other material, it is the legitimate desire of the lumber industry that their selection and use shall be given full consideration. The policy will be to present engineering data relating to timber as a structural material, and in a spirit of helpful service to advocate the use of wood in construction wherever it fully meets all requirements of safety and economy. The information the manufacturers are ready to give should result in mutual benefit, since the thoughtful intelligent use of structural timber will assure the erection of buildings embodying strength, symmetry, fire-resisting qualties and permanence to an extent which will reflect credit on both the material, the designers and the builders, and be looked upon favorably by insurance companies and the compilers of building ordinances. The service proposed goes farther than dissemination of information, because back of the whole movement is Association effort which aims to furnish structural timber which is standard as to size and quality, classified definitely by grading rules, and in the case of some of the more important species, trademarked as a guarantee of grade and quality.

Engineering Data Timber is one of the most essential and widely used materials of construction. Modern engineering practice and the highest development of architectural skill find use for structural timber of many kinds in a wide variety of structures. While many other excellent building materials have come into use for purposes to which they are particularly adapted, timber retains the inherent advantage of economy, permanence, strength and safety. Knowledge of the material, coupled with its wise use, underlie the attainment of these service requirements with any building material. Since timber for many purposes is the most adaptable and the most available of any material, it is important that its possibilities and advantages, as well as its limitations, in standard construction, should be more generally known.

Frank recognition is given to the fact that engineering and scientific study has not been as fully developed with structural timber as with some other materials, nor have the available facts as to the strength and other physical characteristics of woods been given as wide application in construction work as the importance of the material justifies. The comparative absence of these engineering data is, however, a condition of the past rather than the present. The United States Forest Products Laboratory, some of the railroad testing departments, and a number of professional and educational institutions have been accumulating data for many years. While some of the investigations were not in accordance with a comprehensive plan which would lead to uniformly definite results, sufficient facts are at hand to meet all practical requirements.

Timber's Legitimate Place The fundamentals in the proper and satisfactory use of structural timber are that the kind and grade should be properly selected to meet specific service requirements; that the members should be incorporated in the structure in accordance with the best engineering and architectural knowledge of safe and permanent design; and where not suitable for a particular use in its natural state, that the timber should be treated to prevent decay or retard fire and thus adapted to the requirements of the structure. Any building material may fail or become a menace to human life and property if improperly used. The lumber industry knows that its material is safe and economical where properly used. It does not want lumber used under any other condition.

Educational Publicity Structural timber and wood products generally have not been extensively advertised, because of the assumption that their merits were already known. As a matter of fact, wood has been such a common everyday article that the universal familiarity with it has led to a very general rather than specific knowledge of its qualities and uses. More definite information is to be disseminated, not because the average engineer, builder or carpenter does not know the general value of wood for construction purposes, but for the reason that the best use and the safest use come from more intimate knowledge of kinds and grades of timber in relation to the place they are to be used. The strength characteristics, resistance to decay, and possibilities of treatment to adapt non-durable or cheaper grades to proper condition of service are neglected subjects. Since wood is a natural product and is not manufactured in accordance with specifications and methods which give certain uniform results in the finished product, it follows that general knowledge of lumber should be supplemented by the results of technical investigations as to the character and quality of different woods, under varying conditions of growth and service.

Available Supply Good lumber is just as obtainable, possesses the same structural characteristics, and is as safe and economical today as it ever was. In fact, with wider transportation facilities, better seasoning and the closer classification of kinds and grades, timber is more generally available and the quality better adapted to varying requirements than twenty years ago. Supplementing these advantages, are the recent data on physical characteristics, and the development of wood-preserving and fire-retarding materials and processes.

The United States Government estimates conservatively place the amount of merchantable standing timber in the United States at over 2800 billion feet. This is slightly more than half of the original stand, the difference representing what has been utilized for general consumption, what has been cleared from agricultural lands and what has been destroyed by forest fires and waste. During the past fifty years there has been a natural shifting in the sources of lumber production, with a less marked change in the centers of consumption. Industrial development has moved gradually westward and southward, following to an extent the opening up of new forest regions as railroad facilities were extended. In some of the earlier regions of greatest lumber production the supply has been greatly reduced, although local requirements are still supplied, except in large dimension timbers which have to come from the more distant points. But nowhere, even in the treeless regions, is there any difficulty in obtaining structural timber or wood products of kind and quality to meet all needs.

Most of the present available standing timber is in five great forest regions, namely, the Northern, Central, Southern, Rocky

Mountain and Pacific, with fully half the reserve supply in the Pacific Northwest. Rail transportation links each of these with the points of demand. Agricultural and industrial developments have made the great central states and the middle tier eastward to the Atlantic the largest consuming centers. Water transportation now brings the enormous timber supply of the Pacific Coast closer to the larger centers of population in the East; while the cheaper water rates also result in a large movement of lumber from the Gulf ports and the south Atlantic states to the distributing cities in the Northeast.

The present merchantable supply of timber will last nearly sixty years at the present rate of cutting. This, however, by no means indicates that the supply will be exhausted at the end of that period nor that exorbitant prices will ultimately prevail. The protection being given to forests against destruction by fire, the lower per capita consumption, the use of timber more wisely and by treatment or selection assuring longer life in service, the adoption of more intensive and less wasteful logging methods, the utilization of non-agricultural lands for forest production, and the annual growth throughout the enormous forest area will, before a period of exhaustion is at hand, bring the nation's annual wood production up to an amount approximating the consumption, and assure an adequate supply for an indefinite period.

Messrs. W. B. Greeley and H. S. Betts, of the U. S. Forest Service, in a paper presented at the International Engineering Congress in San Francisco September, 1915, state as follows:

> "With its enormous areas of non-agricultural lands, apparently best suited to the production of timber, in the natural order of things, it is probable that the United States will not only supply its own needs but continue to be a large exporter of timber. Even the quality of the lumber placed upon the market, which is of primary interest to the structural engineer, will change but very gradually as old sources of supply renew their stands of merchantable material. For the next thirty or forty years at least, there is no question as to the ability of the United States to furnish high-grade structural timbers from its southern pine and Douglas fir forests, to meet almost any demand for such material from any portion of the world."

As a further indication that lumber of all kinds is available for all purposes, the following estimate (revised November, 1916) of annual production is quoted from "Lumber and Its Uses," by R. S. Kellogg:

Average Annual Lumber Production in the United States.

Species	Million Bd Ft.	Per Cent	Most Largely Produced in
Yellow pine	16,000	38.0	La., Miss., Ala., Tex., N. C., Ark., Ala., Fla., S. C., Va., Ga.
Douglas fir	6,000	14.2	Wash., Ore., Calif.
Oak	3,500	8.3	W. Va., Tenn., Ky., Ark., Va., Ohio
Northern pine	2,500	5.9	Minn., Me., Wis., N. H., Mass.
Eastern hemlock	2,000	4.7	Wis., Mich., Pa., W. Va.
Western pine	1,500	3.6	Calif., Ida., Ore.. Wash., Mont.
Cypress	1,100	2.6	La., Fla., Ga., S. C.
Eastern spruce	1,000	2.4	Me., N. H., W. Va., N. C.
Maple	1,000	2.4	Mich., Wis., W. Va., Pa., N. Y.
Red gum	800	1.9	Ark., Miss., La., Tenn.
Yellow poplar	550	1.3	W. Va., Ky., Tenn., Va., N. C.
Chestnut	550	1.3	W. Va., Pa., N. C., Va., Tenn., Conn.
Redwood	550	1.3	California
Birch	450	1.1	Wis., Mich., Vt., N. Y., Me.
Western cedar	425	1.0	Wash., Ore., Ida., Calif.
Beech	400	1.0	Mich., Pa., W. Va., N. Y., Ohio, Ind.
Western white pine	400	1.0	Ida., Wash., Mont.
Western hemlock	400	1.0	Wash., Oregon
Basswood	375	.9	Wis., Mich., W Va., N. Y.
Western spruce	350	.8	Wash., Ore., Colo.
Western larch	300	.7	Mont., Ida., Wash.
Hickory	300	.7	Ark., Tenn., W. Va., Ky., Ohio, Ind.
Elm	250	.6	Wis., Mich., Ark., Ind., Ohio
Ash	225	.5	Ark., Tenn., La., Wis., Ind.
Cottonwood	225	.5	Miss., Ark., La.
Tupelo	175	.4	La., N. C., Va., Ala.
White fir	140	.3	Calif., Ida., Oregon
Sugar pine	140	.3	California
Balsam fir	140	.3	Maine, Minn., Vt., Mich.
Tamarack	100	.2	Minn., Wis., Mich.
Walnut	90	.2	Mo., Ind., Tenn., Ill., Ohio
Eastern cedar	75	.2	Va., Me., Mich., N. C.
Sycamore	30	.1	Ark , Ind., Tenn., Mo.
Willow	20	.3	Mississippi
Cherry	15		W. Va., Pa., N. Y., Ohio
Buckeye	10		Tenn., W. Va., N. C., Ky.
Noble fir	10		Oregon
Magnolia	10		Louisiana
Not specified	50		
	42,155	100	

The annual average wood consumption, excluding firewood and rails, in the United States for the past few years has been about 52 billion feet B. M. Of this amount some 40 billion feet is in the form of manufactured lumber. The percentage of this total used for construction purposes has not been determined accurately, the best figures indicating that about 20 per cent of the entire consumption is used for engineering consumption. While accurate figures are of no particular value, it is interesting to know that the timber used annually in engineering construction has an estimated valuation of fully $100,000,000.

The per capita consumption in the United States has always been higher than in most other countries—about 500 board feet per capita in 1905—because of the liberal use of the most widely available building material. As wood is used more wisely, its life will increase, and as more timber is creosoted or given other preservative treatment, the annual renewals for any class of structure will naturally decline. On the other hand, educational propaganda and the application of standard and permanent timber construction by the engineering profession, will tend to increase or at least maintain the present lumber consumption for perhaps a decade. Following this, since renewals will be reduced by a more proper use of timber, there will be a falling off in consumption, the demand then being for new structures and for the reduced volume of renewals. To the structural engineer the possibilities in this line are very great.

Quoting again from Messrs. Greeley and Betts:

> "The country is thus evidently drawing upon its forest capital at the rate of 60 to 70 billion feet annually (including the loss by fire and insects). Long before the present enormous forest resources are eaten up, however, it is more than probable that readjusting economic conditions, particularly higher values for timber and a lower per capita consumption, will reduce the annual drain to an amount not more than the annual growth."

Relative Cost The price of lumber has fluctuated in accordance with trade and economic conditions but has never reached an excessively high figure. A comparison between certain species in an abnormal year, such as 1895, with a year of marked business activity as in 1905, would show marked differences in cost. An analysis of prices over a term of years shows, however, that low prices have prevailed over longer periods than the maximum costs, and that even at the peak lumber remained the cheapest building material.

The following tabulation, compiled from the Report by the Census Bureau and Forest Service, shows clearly the course in lumber prices during the last decade.

Average Mill Value of Lumber Per Thousand Feet Board Measure, by Kinds of Wood, for Specified Years: 1904 to 1915.

Kind of Wood	1915	*1912	1911	1910	1909	1908	1907	1906	1904
All kinds......	$14.04	$15.35	$15.05	$15.30	$15.38	$15.37	$16.56	$16.54	$12.76
				SOFTWOODS.					
Yellow pine...	12.41	14.36	13.87	13.29	12.69	12.66	14.02	15.02	9.96
Douglas fir....	10.59	11.58	11.05	13.09	12.44	11.97	14.12	14.20	9.51
White pine....	17.44	19.13	18.54	18.93	18.16	18.17	19.41	18.32	14.93
Hemlock	13.14	13.68	13.59	13.85	13.95	13.65	15.53	15.31	11.91
Spruce	16.58	17.02	16.14	16.62	16.91	16.25	17.26	17.33	14.03
Western pine..	14.32	13.62	13.88	14.26	15.39	15.03	15.67	14.01	11.30
Cypress	19.85	20.09	20.54	20.51	20.46	21.30	22.12	21.94	17.50
Redwood	13.54	14.13	13.99	15.52	14.80	15.66	17.70	16.64	12.83
Cedar	16.10	†14.45	13.86	15.53	19.95	18.03	19.14	18.12	14.35
Larch (Tam'k)	10.78	‡11.96	11.87	12.33	12.68	12.20	13.99	13.50	11.39
White fir......	10.94	9.86	10.64	11.52	13.10	11.38	15.45	12.91	**
Sugar pine	17.40	**	17.52	18.68	18.14	17.78	19.84	16.11	**
Balsam fir	13.79	**	13.42	14.48	13.99	14.36	16.16	**	**
Lodgepole pine	13.57	**	12.41	14.88	16.25	**	**	**	**
				HARDWOODS.					
Oak	18.73	19.63	19.14	18.76	20.50	21.23	21.23	21.76	17.51
Maple	15.21	15.56	15.49	16.16	15.77	16.30	16.84	15.53	14.94
Red gum	12.54	12.60	12.11	12.26	13.20	13.08	14.10	13.46	10.87
Chestnut	16.17	16.62	16.63	16.23	16.12	16.27	17.04	17.49	13.78
Yellow poplar..	22.45	24.06	25.46	24.71	25.39	25.30	24.91	24.21	18.99
Birch	16.52	17.43	16.61	17.37	16.95	16.42	17.37	17.24	15.44
Beech	14.01	13.51	14.09	14.34	13.25	13.50	14.30	14.05	**
Basswood	18.89	19.26	19.20	20.94	19.50	20.50	20.03	18.66	16.86

HARDWOODS—(Continued).

Kind of Wood	1915	*1912	1911	1910	1909	1908	1907	1906	1904
Elm	$16.98	$16.87	$17.13	$18.67	$17.52	$18.40	$18.45	$18.08	$14.45
Ash	22.15	20.27	21.21	22.47	24.44	25.51	25.01	24.35	18.77
Cottonwood	16.77	¶20.44	18.12	17.78	18.05	17.76	18.42	17.15	14.92
Tupelo	12.25	13.61	12.46	12.14	11.87	13.36	14.48	14.13	**
Hickory	23.35	23.29	22.47	26.55	30.80	29.66	29.50	30.42	23.94
Walnut	48.47	**	31.70	34.91	42.79	42.53	43.31	42.25	45.64
Sycamore	13.86	**	13.16	14.10	14.77	14.67	14.58	**	**

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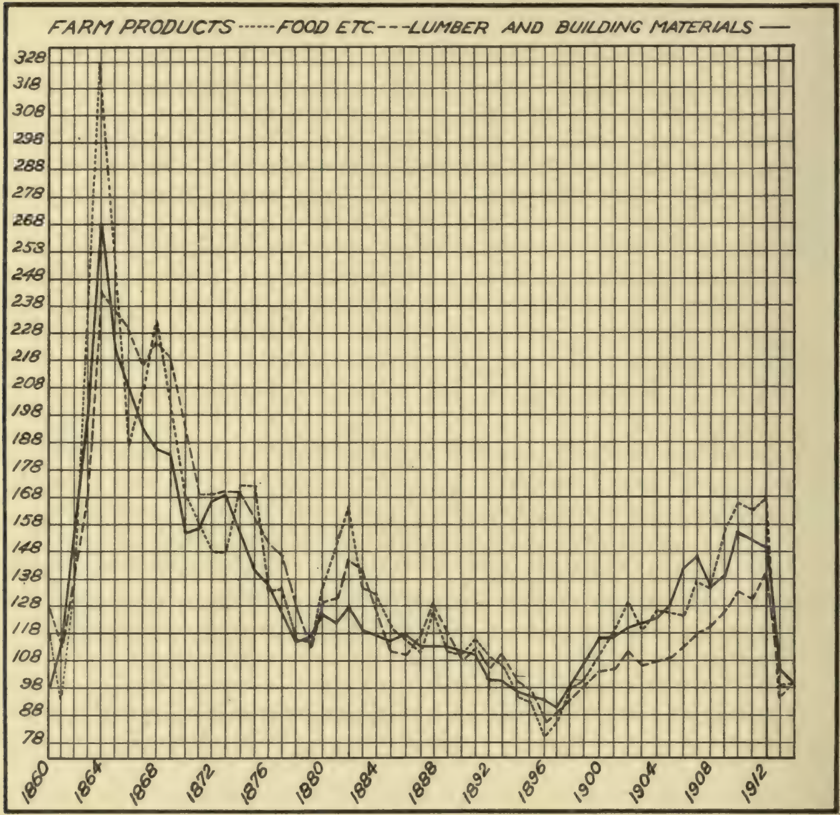
*1912 values based on limited number of reports.
**Data not obtained.
†Western red cedar only.
‡Western larch only.
¶Southern cottonwood only.

The above values are not intended to cover all grades of lumber nor to indicate wholesale or retail prices in any locality. They give, however, a correct comparison of values at the sawmill, to which must be added freight, handling, and service charges. It is clear that there has been no marked advance in lumber prices, in proportion to the general rise in commodity prices during the same period.

The statement that lumber has reached such an exorbitant price that it can no longer be used, is best met by the records of the United States Bureau of Labor Statistics, the authority on the wholesale prices of all commodities. On page 266 of Bulletin 181 of the Bureau is given a table of the relative prices of nine groups of commodities from 1860 to 1914, the average price from 1890 to 1899 being taken as 100. The chart on page 12 shows in graphic form the record of the Bureau for three of the most important groups of commodities; farm products, food, and lumber and building materials. On the chart, farm products are indicated by a dotted line, food by a line of dashes, and lumber and building materials by a solid line of dashes, and lumber and building materials by a solid ular statements as to undue advances in lumber prices. On an average, these prices have run between those of farm products and of food for the last fifty years, and with neither as high points nor as low points as the two other groups. Still further, it will be noted that the prices of lumber and building materials



are relatively lower now than they were forty years ago; yet at that time no one thought that lumber was too expensive to build with. The price of lumber, as shown by the Federal Census Bureau, was 10 per cent less in 1915 than in 1906. By comparison, the general level of commodity prices has advanced 33 per cent in seven years.

Modern Structural Requirements Modern structures impose very strict requirements on the material used. It is for the structural engineer rather than for the consumer to determine what material is best in particular locations. This selection is further determined by city building codes, by the need for safety from fire, and the necessity for permanence in congested city districts.

It is a logical conclusion that structural timber should not be used in sky-scraper districts. The question of wooden floors, doors, inside trim, and fire-resistant construction is a problem for the engineer. There is ample evidence that the tendency in many cases has been to go too far in the elimination of wood, since its modern use for these purposes is not the contributing cause of fire. At any rate, the character of the contents is the underlying conflagration hazard in many cases, as evidenced by the burning out of the central districts of cities such as Baltimore and San Francisco.

For factory and warehouse purposes, suburban and country dwellings, and in many other situations, wood may safely predominate, and if properly used meets all requirements. With the basic facts of availability and economy established and data available as to strength and durability, the engineer can readily specify the extent to which structural timber may be safely used to the advantage of the owner or community.

Permanence and Depreciation Permanence as applied to construction is a relative term, since outside of definitely planned and congested city districts permanence may mean a building lasting ten years or fifty years, according to the conditions. Both commercial buildings and dwellings serve their original purpose only while community or industrial conditions make their occupancy attractive or profitable. The growth of nearly all American cities has forced the transition of residential streets to factory or warehouse districts, with no way of anticipating ultimate developments. The capitol at Washington, for instance, does not face the main part of the city, because it did not grow in the direction which was anticipated.

The lack of stability in city development does not mean that strictly temporary, unsafe, or unsightly structures should be built, but it does indicate definite advantages in the use of timber as the main structural material in dwellings and commercial buildings of moderate size and cost. Many mill constructed buildings in New England are practically as good today as when built a hundred years ago; while frame dwellings will last for generations, as evidenced by colonial homes which are still sound and comfortable after more than a century of use. The main point is that whether used for permanent or temporary purposes, timber structures may be removed or changed more readily, and may be adapted and remodeled more economically than if built of materials which in themselves are claimed to be more permanent.

The question of depreciation in buildings of all kinds is very important. So many factors must be considered that depreciation on any type of building—wood or other material—cannot be fixed on any absolute rule or percentage, nor in an arbitrary manner. Service records on wooden, brick, and stone buildings run back through many years, and establish a basis for average depreciation figures. Some of the newer building materials, however, as well as some of the newer types or designs in structures, have not been given this test of time. In buildings of the standard mill construction type depreciation is commonly estimated at from 1 to 1½ per cent annually. This, of course, is based upon well designed buildings, properly constructed of good materials.

Comparative depreciation charges are more or less arbitrary, because they depend not only on the actual life of the building and on the character of the occupancy, but on the indefinite period of usefulness, regardless of the material. Taking into consideration several principal factors, such as community changes, expansion of city growth, developments in architectural types, and housing requirements, a thirty to forty year period is a fair estimate of the term of usefulness of any kind of structure. In view of this, well designed and properly built timber structures will in many cases meet all requirements of occupancy and use, and prove very economical, both in first cost, and in ultimate alterations or removal.

Fire Hazard A stick of timber will burn and so will a wood, a brick, a concrete, a steel or a terra cotta building. Buildings burn, not because of the materials of which they are built, but on account of faulty construction, lack of fire precautions, hazardous contents and carelessness. The enormous annual fire losses in the United States very properly constitute a subject of national concern and every possible measure should be taken for their reduction. But that the general use of wood in the ordinary types of buildings is the basic cause of fires is not a reasonable assumption.

To condemn wood in any form and to advocate the use of noncombustible building material has been the aim of several publicity campaigns. The American people are too sane to be led into a frenzy of condemnation against a material which has sheltered and served them from time immemorial, and certainly engineers and architects will continue to select building material on its merits. The first consideration in the use of timber is that it should never be placed in a structure where underwriting experience has not shown it to be reasonably safe. On the other hand, its elimination because of the wide-spread slogan that "wood burns," and in favor of more expensive, less adaptable and less beautiful materials which have not stood the service test of time, is as unreasonable as to drink wine instead of water because the latter may contain disease germs. There is a happy medium based on common sense and statistics.

One of the greatest fallacies is that of drawing conclusions regarding fire losses from per capita data. To say that the annual fire loss in the United States is $2.50 per capita against 58-cent per capita loss in Europe is to ignore a necessary measure of value. The fact that the United States has about three and one-half times the number of fires and also very nearly three times the number of buildings, leads to the simple conclusion that Europe has fewer fires because it has fewer buildings. Not only do we have nearly three times the number of buildings but substantially twenty-five per cent less population. These figures are gleaned from the Underwriters' report for the year 1913. It develops from this same source of information that the average loss per fire in the United States was $532, while the average in European cities was $82 greater or $614. From this it is apparent that the average building in the United States is a fourteen per cent better fire risk than the average building in European cities.

The whole fire question with respect to timber construction largely resolves itself into the fact that the public has been told about the fires in wooden buildings, while little or nothing has been said about what actually happens to buildings of non-combustible material. Fire prevention propaganda, based on proper construction, adequate safeguards, elimination of hazardous contents and carelessness, and the use of automatic sprinklers, will be welcomed by the lumbermen and go farther towards actual reduction of losses than an attempt to create prejudice against wood.

A great many reports on fire prevention and the use of structural materials in building, state that a carefully designed timber structure is as safe against fire as any other type of structure if all floors are isolated, elevators and stairways enclosed in fireproof shafts with all openings protected by self-closing doors, and proper sprinkler systems used throughout.

A heavy timber which has been charred by fire becomes of slow-burning nature due to the charred coating, in the same manner that a solid log burns slowly. Even when charred, the timber loses but little of its original strength, and the building is not distorted nor weakened perceptibly.

Mill Construction Mill construction is a type of structure which has been well known to engineers for many years. Its advantages as an economical and substantial form of building for warehouses, factories, and many other uses are as strong today as ever, if properly designed with well-selected structural timber. Heavy mill construction with a sprinkler system is a very acceptable fire risk, as evidenced by its being preferred over all other risks by strong mutual fire companies in New England. In this same territory it is stated in "Engineering of Shops and Factories" by H. G. Tyrrell, C. E., that there are more wood-framed mills than all others combined.

Engineering Bulletin No. 2, of this Association, defines and discusses heavy timber mill construction buildings from the standpoint of the structural engineer.

Dwellings The frame dwelling is our commonest type. It is cheap, beautiful if properly designed, permanent if built of well-selected timber, and fully meets all of the requirements of the home builder and real estate owner. Many of the possibilities and advantages of the moderate priced frame home have been ignored or overlooked because no architectural skill or training was utilized in the design or construction. Model plans are available from many sources, and while they are of great assistance to the man who cannot afford to consult an architect, it would be economy in the long run if such buildings, especially of the more pretentious type, could be constructed under the supervision of competent architects.

A point frequently overlooked in considering other than frame construction for the dwelling is the relative heat radiation in walls of various kinds. In tests made by the German Government of heat transmitted per square foot of wall surface per hour, it was found that the frame house, with 7/16 inch clap-boards, building paper, sheathing, lath and plaster, had a heat loss factor of .23 of a B. T. U. per degree as against .37 for plain brick walls one brick thick, and .36 for brick walls one brick thick plastered inside.* In stone walls a thickness of 20 inches is required with sand stone to reduce the heat factor even to .35, while with a 12-inch stone wall the loss was .45. Concrete blocks are in about the same class as limestone in coldness and will have a heat loss factor of about 35 to 50 per cent more than frame construction.

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*For further details reference is made to a publication on heating and ventilating issued by the Buffalo Forge Company of Buffalo, N. Y.; also to the book on "Heating and Ventilating Buildings," by Carpenter.

With the public at present somewhat influenced by the bugaboo that "wood burns" many prospective builders attempt to use non-combustible materials. Here again amateur effort is not likely to bring gratifying results, and if the architect is called in the builder will have an opportunity to learn the actual relative merits and fire hazard of different types of dwellings. Even if the factors of beauty and economy can be taken care of in the home built of other than frame construction there remains the fundamental cause of fire, which is in no way influenced by the character of the structure. The elimination of individual carelessness is the first essential, after which the severity and frequency of the dwelling house fire is determined by the character of the contents.

The frame dwelling has advantages of warmth, low cost, beauty and comfort which no other type can equal. All the sentiment of home centers around the "homey" character of the wood of which it is built. The treasures of the home will burn as quickly and completely within non-combustible walls as in a frame of wood. To banish the fire hazard, we should build for safety by cutting off vertical openings, by proper flue, chimney and fireplace construction, and, if the home is not isolated from neighboring dwellings, by using a fire-retardent compound on the wooden shingles and a fire-resistant paint on the side walls. Then eliminate individual carelessness, take proper precautions always, and the home and all it means will be safeguarded.

Fire Retardents A development which increases the adaptability of wood for many purposes, is along the line of fire retardents. Processes and materials have been perfected which are eminently practical. They are in most cases a paint or chemical, which can be applied with a brush or by an immersion process. Special investigations on this subject are in progress and for the present it is sufficient to say that there are now on the market fire retardents which are especially adapted to shingles, and will render them permanently fire resistant in greater measure than many of the so-called fireproof roofings. Some of these same materials may be applied to other portions of the structure where it is advisable to give protection to exposed woodwork.

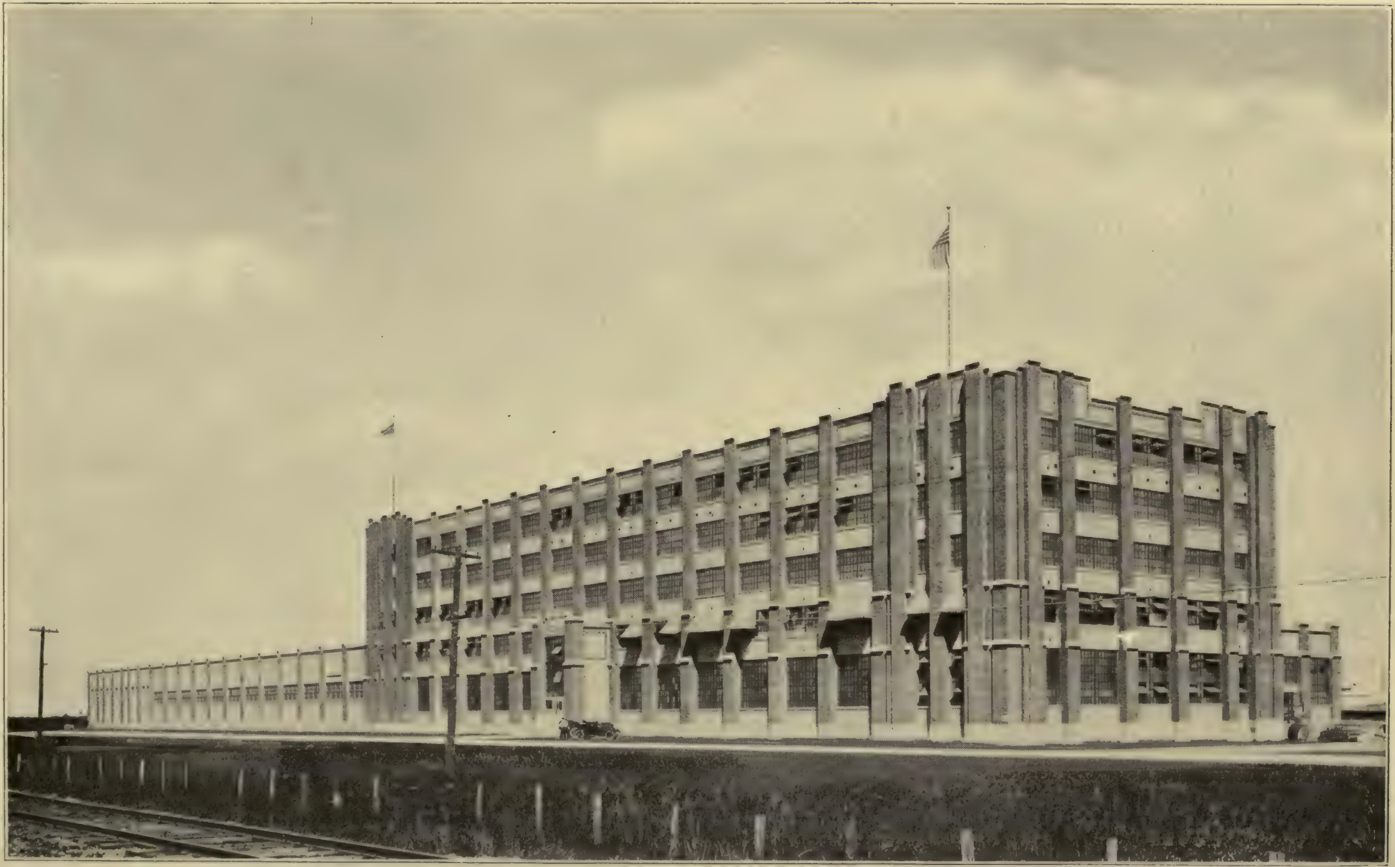
The same influences which have created a prejudice against the use of structural timber in commercial structures and frame dwellings have attempted to eliminate the shingle roof. The propaganda is based entirely on the fire hazard, since it is well known that good shingles, properly laid with good nails, will give better service than any other form of roofing material, and in case of fire in adjacent buildings can be wet down so as to constitute an excellent fire break. No one denies that a dry shingle roof, particularly an old one, will ignite from brands and large sparks, nor does any sane man, lumberman or otherwise, advocate other than non-combustible roofs in congested city districts or wherever there is real danger. But it is equally certain that many other roofing materials are in the same class with shingles as regards inflammability, and where buildings are separated as in small towns and residential districts, the wooden shingle has qualities of beauty, economy, storm resistance, and long life superior to any other roof covering.

Wood Preservation With the advance in engineering knowledge there have come important developments in the preservative treatment of structural timber against decay. Treating processes have been applied on a commercial scale in Europe for over a century, and in this country for some forty years. The most extensive acceptance of this practice has been by the railroads for treatment of cross-ties and structural timbers, bridges, trestles, docks, etc. It is entirely feasible, however, to apply the same methods to the treatment of structural timbers in many types of buildings, and the possibilities along this line have been largely overlooked. Steel is painted to prevent rust, concrete is coated to prevent abrasion and to add waterproofing qualities, so it is entirely reasonable and in no way a reflection on the stability of timber that under certain conditions it should be treated with creosote, or some other preservative, to prevent decay.

The inside timbers in many buildings where exposed to moisture should be treated with creosote. All timber in contact with the ground may be preserved indefinitely against decay. Mud sills and beams on foundations, basement planking, stringers, and other structural parts may be creosoted to give permanence and stability. This not only reduces renewals to a minimum but establishes a constant factor of safety, since there is no reduction in strength from decay. Such timbers if given an empty cell treatment and left exposed to the air before being put in place will have no objectionable odor. In situations where the color or use of creosote for any reason would be objectionable zinc-chloride may be used.

The intelligent use of wood-preserving methods has the further advantage that the factor of durability in structural timber can be largely ignored and consideration given only to strength requirements. Many timbers which are naturally non-durable are cheaper than the more durable woods, thus effecting in the first cost a saving which largely covers the expense of treatment.

Summary In this introductory publication an attempt has been made to review briefly the many diversified phases connected with the use of structural timber in modern construction. The general announcement that the lumber manufacturers are preparing and publishing a series of technical bulletins dealing with timber and wood products in all forms should be welcomed by all architects, engineers and builders. Their libraries have contained reference books on practically all building materials except wood, and this lack will now be supplied with the best engineering data on structural timber and wood construction. These publications have been made readily available to all who are interested.



A Modern Mill Construction Type of Manufacturing Plant.

(Frank D. Chase, Industrial Architect and Engineer, Chicago.)

Heavy Timber
Mill Construction Buildings

BY

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Chicago

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Engineering Bulletin No. 2 October, 1916, Edition

Heavy Timber Mill Construction Buildings

By C. E. Paul, Construction Engineer

CHAPTER I.

MILL CONSTRUCTION DEFINED.

The term "mill construction" as commonly used is the name given to that type of building construction in which the interior framing and floors are of timber, arranged in heavy solid masses, and smooth flat surfaces, so as to expose the least number of corners, and to avoid concealed spaces which may not be reached readily in case of fire.

A broader interpretation of the term includes the meaning given above and adds the specification that the building shall be so constructed that fire shall pass as slowly as possible from one part of the structure to another. This means that each floor should be separated from all others by incombustible walls or partitions, and by doors or hatchways which will close automatically in case of fire near them. Stairways, belt passages, and elevator shafts are encased, or preferably located in fireproof towers. Openings in floors for passage of belts, etc., are either avoided or fully protected against passage of fire or water. The proper installation of an approved automatic sprinkler system is of great importance. Ceilings in rooms where highly inflammable stocks are kept or where hazardous processes are followed, should be protected by the use of fire-retardant material. The ceiling should follow the lines of the timbers without an air space between the two surfaces.

Origin of Type The "mill construction" type of building originated in the cotton and woolen mills of New England in the early days of that industry. Instances of buildings of the mill construction type are found in the early part of the nineteenth century, but no great prominence was given to this particular type of structure until the owners of a large number of these mills formed an organization about the year 1835 for the mutual protection of their property from damage by fire. The outgrowth of this primary organization was the formation of the Associated Factory Mutual Fire Insurance Companies.

The results of the combined interests of the factory owners were shown in the recommendation of a standard type of mill building which had proved its value not only through permanence, but also by its fire-resisting qualities. City building ordinances at the present time model their requirements for buildings of the mill construction type largely upon the original suggestions of these mutual insurance companies.

An instance of the durability of timber in properly built mill construction buildings is shown in the Warner mill in Newburyport, Mass. In this building heavy timber girders 45 feet long and spanning three bays have carried their load since the early 50's without signs of failure, and are said to be in as good condition today as when installed. While girders of this length are not common at the present time and shorter lengths are used for the same purpose, this instance shows the dependence which may be put in mill construction when properly selected timber of a high quality is used.

What Mill Construction Means Today

The marked success of early heavy timber structures of the mill construction type led to the popular use of this form of construction in practically all kinds of large buildings. As its use developed, new problems arose which made necessary a departure from the original designs. This variation to suit the case in hand finally resulted in three general classes of framing, each commonly referred to by builders as mill construction. These classes have certain basic points in common, such as heavy timber, brick, stone, or concrete walls; stairways and elevators enclosed in fireproof shafts or towers; floors with no openings or with all openings protected by fireproof covers; each floor or room isolated by means of automatic fireproof doors or fire walls; windows protected by shutters or by the use of wire glass; sprinkler equipment, etc.

These three general types of framing may be classed as follows:

1. Floors of heavy plank laid flat upon large girders which are spaced from 8 to 11 feet on centers. These girders are supported by wood posts or columns spaced from 16 to 25 feet apart. This type is often referred to as "Standard Mill Construction."
2. Floors of heavy plank laid on edge and supported by girders which are spaced from 12 to 18 feet on centers. These girders are supported by wood posts or columns spaced 16 feet or over apart, depending upon the design of the structure. This type is called "Mill Construction with Laminated Floors."
3. Floors of heavy plank laid flat upon large beams which are spaced from 4 to 10 feet on centers and supported by girders spaced as far apart as the loading will allow. These girders are carried by wood posts or columns located as far apart as consistent with the general design of the building. A spacing of from 20 to 25 feet is not uncommon for columns in this class of framing where the loading is not excessive. This type is more generally known as "Semi-Mill Construction."

Each of these types is provided with a lighter top-floor to take the wear and give a finished surface. Construction details will be given in the chapters which follow.

What Mill Construction Is Not In order that all sides of the question may be presented, the following abstracts from Report No. V, issued by the Insurance Engineering Experiment Station under direction of the Boston Manufacturers Mutual Fire Insurance Co., may aid in eliminating erroneous ideas.

"Mill-construction does not consist in disposing a given quantity of materials so that the whole interior of a building becomes a series of wooden cells; being pervaded with concealed spaces, either directly connected each with the other or by cracks through which fire may freely pass where it cannot be reached by water.

"It does not consist in an open-timber construction of floors and roof resembling mill-construction, but of light and insufficient size in timber, and thin planks, without fire-stops or fire-guards from floor to floor.

"It does not consist in connecting floor with floor by combustible wooden stairways encased in wood less than two inches thick.

"It does not consist in putting in very numerous divisions or partitions of light wood."

"It does not consist in permitting the use of varnish upon woodwork over which a fire will pass rapidly.

"It does not consist in leaving windows exposed to adjacent buildings unguarded by fire-shutters or wired glass.

"It is dangerous to paint, varnish, fill or encase heavy timbers and thick plank as they are customarily delivered, lest what is called dry-rot should be caused for lack of ventilation or opportunity to season.

"It does not consist in leaving even the best-constructed building in which dangerous occupations are followed without automatic sprinklers, and without a complete and adequate equipment of pumps, pipes, and hydrants."

"It follows that if plastering is to be put upon a ceiling following the line of the underside of the floor and the timber, it should be plain lime-mortar plastering, which is sufficiently porous to permit seasoning. The addition of the skim-coat of lime-putty is hazardous, especially if the top-floor is laid upon resin-sized or asphalt paper. This rule applies to almost all timber as now delivered.

"All the faults above recited have been committed in buildings purporting to be of mill construction, and all form a part of the common practice in 'combustible architecture.' "

Mill Construction and Slow-Burning Construction

The terms "mill construction" and "slow-burning construction" are used in most instances without a true clearness of meaning. It is true that mill construction is one of the best types of slow-burning construction, but there are other types of structures which are referred to under this same classification. The popular distinction is best shown in the building ordinances of various cities. In mill construction, only timbers of large size are used, but in slow-burning construction small timbers protected by metal lath and plaster or other fire resisting materials are frequently installed. Instead of the thick floors required in mill construction, lighter material is used with a fire retardant layer between the under floor and the wearing surface. Plaster covered steel or iron members may also form the main part of the framing in this latter type of building. The following abstracts from the 1915 Revised Building Ordinance of the City of Chicago will illustrate this distinction.

"*Slow-Burning Construction Defined.* The term "Slow-Burning Construction" shall apply to all buildings in which the structural members, other than walls elsewhere required to be of masonry which carry the loads and strains which come upon the floor and roofs thereof are made wholly or in part of combustible material, but throughout which the structural metallic members, if used, shall be protected against injury from fire by coverings of fireproof material. Underside of joists shall be protected by a covering of three coats of plaster laid on metal lath; and a layer of mortar or other incombustible material at least one and one-half inches thick shall be applied on all floor and roof surfaces above the joists of the same. Wood posts, if used, shall be of not less than one hundred square inches sectional area. Wood girders, if used, shall be of not less than seventy-two square inches sectional area."

"*Definition—Mill Construction Requirements.* The term "Mill Construction" shall apply to all buildings in which wooden posts, if used, have a sectional area of not less than one hundred square inches, and wooden girders and joists a sectional area of not less than seventy-two square inches, and roofs, if of wood, a thickness of not less than two and five-eighths inches in a single layer, and floors, if of wood, a thickness of not less than three and one-half inches in not more than two layers, the lower one of which shall not be less than two and five-eighths inches in thickness, and in which all structural metallic members, if used, are fireproofed as required for fireproof construction, and in which all floors and roofs not constructed as above are of fireproof construction as elsewhere required for fireproof construction in this ordinance."

A Typical New England Mill Construction Plant.
(Chas. T. Main, Engineer, Boston.)

Mill Construction Used to Advantage Mill construction has always been looked upon with favor for buildings in which ordinary manufacturing industries are carried on. Warehouses and buildings for storage of merchandise, stores, office buildings, factories, shops, and all buildings of moderate height which are not to be used for extremely hazardous purposes from a fire protection standpoint, are later developments of this type of construction. City building codes limit the height of building and size of open spaces in buildings. They also specify the minimum sizes of timber which shall be used, and other similar details.

The following extract from the report of G. B. Hegart, Engineer, The Commission of Public Docks, Portland, Oregon, for the year ending November 30, 1915, indicates a few of the special advantages of mill construction:

> "The adoption of heavy mill or slow-burning construction in preference to fireproof construction, was done both on account of the saving in the initial cost and the necessity of taking into consideration the useful or commercial life of structures of this character, as it is not at the present time possible to forsee the type of waterfront structures that will be demanded to meet changed requirements twenty-five or thirty years hence, when extensive alterations may have to be made to present structures, which can be more readily accomplished in timber than in fireproof construction, or an entire new design may be found necessary to meet the changes in requirements."

Mill Construction and the Architect This bulletin is intended to supplement as an educational treatise, and to aid technically, the work of the architect or engineer who may not have the time or opportunity to compile such information for himself. While heavy timber mill construction buildings are easy to build and have the results of long experience to guide the builder, the services of a competent architect or engineer are always advisable. In no class of buildings can safety and economy of design be more positively assured.

CHAPTER II.

EXTERIOR WALLS, FIRE WALLS, AND ENCLOSURES.

Foundations The stability of any building depends to a great extent upon the nature of the foundations and the bearing power of the soil upon which these foundations rest. Not only must the walls have footings of sufficient size, but all piers which support columns or isolated loads must also be provided with ample bearing surface. Heavy machines or equipment may be supported upon foundations which are separate from the main foundations of the building. This is advisable in all cases where heavy shocks or vibrations are likely to occur.

The footings and foundation walls of modern mill buildings are of plain or reinforced concrete. A lean mixture of one part Portland cement, three parts clean sand, and five parts of broken stone or screened gravel, should be suitable for footings in ordinary cases, while a 1:2:4: mixture will make strong, watertight foundation walls if the materials are carefully graded and properly handled. It is essential that the concrete be extremely well mixed.

Safe bearing values for different kinds of soil to be used in preliminary estimates are as given in Table I. If exact values are needed in doubtful soils, bearing tests should be made.

Table I.—Bearing Power of Soils.

Rock	10 to 200	tons	per	sq.	ft.
Gravel, compacted	8 to 10	"	"	"	"
Sand, clean and compact	4 to 6	"	"	"	"
Clay on thick beds, always dry	4 to 6	"	"	"	"
Clay on thick beds, moderately dry	2 to 4	"	"	"	"
Sand, clean and dry	2 to 4	"	"	"	"
Dry earth	1 to 2	"	"	"	"
Quicksand and wet soil	½ to 1	"	"	"	"

The unit bearing on footings should be proportioned in such a manner as to allow equal settlement under all parts of a structure. In general, footings for natural foundations should be made 1 foot 6 inches, or 2 feet thick. If pile foundations are used, the footings should be made 3 feet thick with the pile head extending 1 foot into the concrete. Foundation piles should not be spaced closer than 2 feet on centers in any direction, and at least 2 feet 6 inches should be allowed in one direction. Wood piling should always be cut off below water level unless creosoted. Thorough creosoting is recommended for all exposed piling.

Wherever exposed to the action of frost, footings should lie from 4 feet to 6 feet below grade, depending upon the climatic location. In any case footings should be carried to the firmest bearing strata within reasonable reach.

The thickness of the foundation walls or the size of the isolated piers will depend upon the load to be carried. This load is determined approximately from preliminary plans of the building, and from the weight of machinery, equipment, or materials which is to be carried on the floors of the structure. In calculating the live load, allowance must be made for the effect of impact from machines and equipment together with the overturning effect on the leeward side due to the wind.

If the soil is wet and a dry interior is to be assured, the basement walls and floor should be waterproofed during construction. This waterproofing may consist of a continuous layer of bituminous material placed on the outer surface of the walls, extending through the walls at the footings, and forming a tight membrane under the wearing coat of the basement floor, or by the use of a rich, properly graded mixture of Portland cement concrete containing a reliable integral waterproofing compound.

Exterior Walls City building ordinances as well as the recommendations of insurance underwriters generally specify exterior walls of an incombustible material such as brick, stone or concrete. The pilastered form of brick or reinforced concrete wall gives large window areas and furnishes support to the main girders of the floors where needed, but may lack the rigidity of a solid wall. This general type of construction may be carried out either in the form of curtain walls or panel walls at the choice of the designer. In the absence of a local building ordinance which determines the proper thicknesses to be used in the different parts of brick or concrete exterior walls, it is suggested that the sizes given in the Building Code Recommended by the National Board of Fire Underwriters be followed.

In small buildings or structures located well out of conflagration districts and separated from other buildings, exterior walls are occasionally made of heavy timber construction as in the case of floors. The posts which are to form the exterior framing should be of a size needed to carry the load from the floor above, but should not be less than 10 inches by 10 inches. These posts should be spaced from 8 to 10 feet apart as in the case of the floor girders, and should be thoroughly braced at the corners of the building and around openings to provide stiffness.

The walls may be of plank 2 inches or more in thickness. Tongued and grooved or splined material is placed vertically and nailed to horizontal girths extending between the posts. Square-edged plank may be used by covering the cracks with ½-inch battens. If metal siding or slate is to be used as an exterior finish, the planks should be placed horizontally and fastened to the posts and intermediate studs if needed. Planks nailed diagonally will aid in stiffening the building, but there is a small waste of material involved. All interior surfaces should be left exposed so that water may reach them easily in case of fire.

Fire and Party Walls Fire walls and party walls should be built of brick or reinforced concrete and should extend 3 feet above roof. The thickness and general design is regulated by the local ordinance, or may be governed by the recommendations of the National Board of Fire Underwriters. For the sake of economy designers should take care to keep the floor areas of the maximum proportions at which fire walls are not required, as the cost of fire walls and the protection of openings in walls, add materially to the cost of a structure. Maximum floor areas between fire walls or exterior walls of mill construction buildings not over 65 feet high as recommended by the National Board of Fire Underwriters are as follows:

	Without Sprinklers	With Sprinklers
Building fronting on one street............	6,500 sq. ft.	13,000 sq. ft.
Building fronting on two streets...........	8,000 sq. ft.	16,000 sq. ft.
Building fronting on three or more streets..	10,000 sq. ft.	20,000 sq. ft.

Local building ordinances may vary from these areas and should be consulted in any case. Many examples may be found in the cotton and woolen mills of the New England States in which these areas have been exceeded, even in the practice of leading engineers and architects. The weave room of one large mill is said to have a floor area of five and one-third acres.

Enclosure Walls Walls which serve as enclosures for stairways, elevators, etc., should be self sustaining and of incombustible material. Brick walls not less than 12 inches thick, or reinforced concrete not less than 8 inches thick are commonly used for this purpose. In special cases where the wall is less than 8 feet on a side and has no openings, a brick wall 8 inches thick may be used if it does not extend more than one story in height.

The walls of stairways and elevator enclosures when inside of a building should extend through all floors and rise about 3 feet above the roof. No interior windows should be allowed, and all openings from the different floors should be protected by automatic fire doors. All stairway doors should be self-closing.

Belts or power drives should be located in a special tower or shaft constructed of incombustible material as in the case of stairways and elevators. Openings to such shafts should be self-closing.

CHAPTER III.

FLOORS.

General Construction One of the distinctive purposes of mill construction is to obtain strength and stiffness with a minimum amount of timber surface and corners exposed to attack by fire. Large supporting members and flat, smooth, heavy floors provide this requirement. Large timbers do not ignite readily, and if exposed to fire burn slowly and with but slight penetration after a considerable period of time. Flat, smooth surfaces possess this same resistance to combustion, and may be reached easily by water from sprinklers or hose. While three general types of construction were described briefly in Chapter I, each type is based upon these fundamental principles and varies only according to the needs of design in a given case.

Heavy timber posts support large timber girders spaced as far apart as the design will allow. These girders support a thick main or carrying floor direct without aid of joists or smaller timbers, except in semi-mill construction. The main floor is covered with two or more layers of waterproof paper, or similar material, to prevent leakage of water or passage of dirt from the floor above. In usual practice a hardwood top or wearing floor is laid on the paper and completes the total thickness of floor. Edge-grain flooring of other woods may also be used; while a new end-grain flooring of small blocks glued to a solid base gives promise of success.

The factor of safety used in calculations for size of girders and columns is sufficient to allow serious charring by fire and still leave strength to support the floor loads. Wood posts have successfully withstood fire that would have entirely crippled unprotected cast iron or steel columns.

Beams of sufficient strength to carry the imposed loads may deflect or vibrate under the action of machinery or impact; therefore, the factors of weight, deflection, vibration and impact should be considered in finding the dimensions of beams that may be used in a given case.

Size of Bays The width of floor and roof bays will vary from 8 to 11 feet on centers where the planks of the main floor are laid flat and no intermediate beams used. If the planks are set on edge, the bays will commonly vary from 12 to 18 feet in width, depending in any case upon the general design of the building, the amount of floor load, and an economical arrangement of the pipes for the sprinkler system. Economy in the use of lumber is effected by making the span such that the full working strength of a given commercial size of material may be utilized, and the material used in standard lengths. Excessive deflections must be guarded against in any design.

The length of bays may be as great as 20 to 25 feet, but 16 feet is more common in ordinary buildings. Again, the design of the building and the sizes of material easily obtained determine this dimension.

Crosby and Fiske in their "Hand Book of Fire Protection" refer to the width of bays as follows:

> "Narrow bay construction (4 feet to 5 feet center to center of timbers) is not true mill construction and is undesirable for several reasons. There are more corners, angles and surfaces on which fire may feed and spread. Water from sprinklers or hose streams cannot be used as advantageously. Owing to the expense, and also because of the greater number of sprinklers in the same fire area, it is not always feasible to place a line of sprinklers in every bay, and if this latter is not done the sprinkler protection is not as satisfactory. Less than 6 foot bays are not advised, and if used the building should not be classed as of 'mill' construction."

Height of Stories The height of different stories of a building may be controlled by the character of occupancy or by special processes necessary in the manufacturing industries. Where no special features are to be provided for, the heights shown in Table II may be used as a guide:

Table II.—Height of Stories from Floor to Floor.

Width of Building	Height of Stories
25 feet	12 feet
50 feet	13 feet
75 feet	14 feet
100 feet	15 feet
125 feet	15 feet

The National Board of Fire Underwriters recommend that no story of any building above the first story shall exceed 15 feet in height.

Minimum Sizes of Material Building ordinances and insurance codes or specifications have established certain minimum sizes of girders and thickness of floor plank. This action tends to preserve the distinctive points of mill construction, and separate it from ordinary light framing. While all ordinances and codes do not agree in detail, the same purpose is indicated in each.

Girders or beams are commonly required to be at least 6 inches in either dimension, and often a cross-section area of 72 square inches is demanded. Some cities require 8 inches as a minimum dimension. All timbers are to be planed on all sides.

The main or carrying floor should be at least 3 inches thick with tongued and grooved or splined joints if laid flat upon the girders. For plank 4 inches or more in thickness, the edges should be grooved to take a ¾-inch by 1½-inch spline. The top wearing floor may be of a 1-inch material. All material should be surfaced on all sides. The sizes given above are nominal and not actual.

Girders Although a minimum dimension of 6 inches (nominal) is specified by building ordinances and insurance recommendations, girders of greater depth than width are commonly used. Formulas for finding the size of girder to carry a given floor load will be found in a special section at the end of this bulletin.

Girders are preferably of single stick, but for sizes above 14 inches by 16 inches it is often advantageous to use two pieces 8 inches by 16 inches, or a similar combination, bolted together securely side by side with the larger dimension vertical. It has been the custom to leave an air space about ¾-inch wide between the two members thus fastened, but modern practice favors placing the two girders close together without air space. It is claimed that the space between double members allows the entrance of fire into a place which is difficult to reach with the ordinary sprinkler system or even with a stream from a hose.

Bolts ¾-inch diameter fitted with nuts and 3-inch washers are often used to fasten double girders. The extreme bolts are placed about 2 feet in from the ends, while the others are stag-

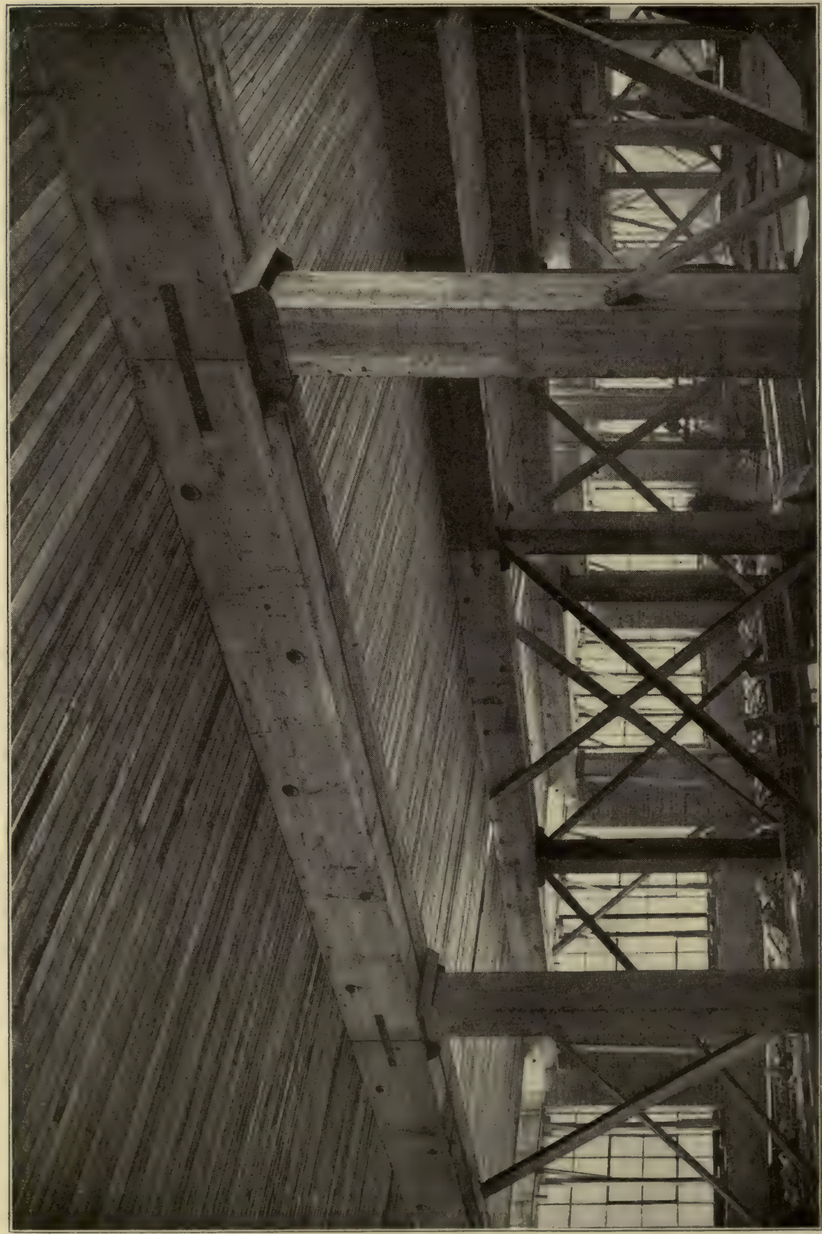


Fig. 1. Heavy Timber Framing with Laminated Floor.

gered at equal spacing along the length. The spacing longitudinally should not be greater than four times the depth of the girder.

Where girders meet at the columns, they should be fitted around the column or butted up close to it. The ends of girders may be drawn together closely by dogs driven into the top side, or held in place by steel or iron straps spiked, bolted, or secured by lag screws, as shown in Fig. 1. If the style of post cap will allow, the sides of the post cap which project upward may be used as straps for the girders.

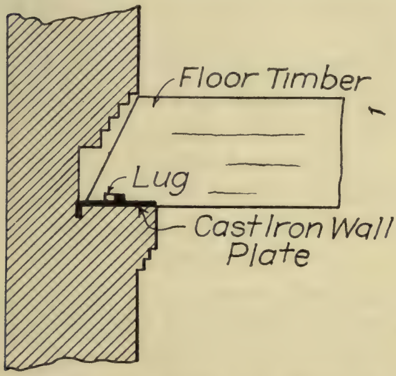


Fig. 2. Method of Supporting Girder on Wall Plate.

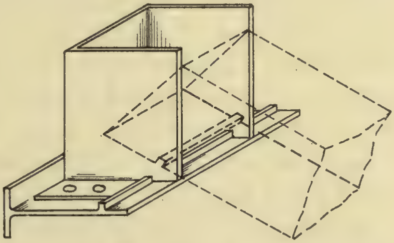


Fig. 3. Wall Box for Holding End of Girder in Wall.

The length of the bearing at the ends of girders should be such that the bearing area will be sufficient to allow a suitable unit stress in compression across the grain of the wood. A minimum length of 5 inches is often required, but an exact determination should be made after the width of girder is known. Methods of calculation and values of unit stresses for compressive strength of timber will be found in a section at the end of this bulletin. If the local building ordinance specifies definite values, they should be used in all calculations.

Girders are supported at the wall by metal wall plates or wall boxes built into the wall as shown in Fig. 2 and Fig. 3, thus distributing the loads more evenly on the brickwork. Wall plates should have two flanges—one to anchor the plate to the wall, and the other to hold the girder on the plate. Care should be taken to see that a ½-inch air space is left around the ends of girders for ventilation, so as to prevent the appearance of dry rot. A preservative treatment applied to the wall ends of the girders will give added security. It is advisable to allow end play in girders to prevent strains in the walls. Ends of girders should be cut at an angle such that in case of damage by fire, the member may tip out of the wall opening without disturbing the wall. At columns, girders are supported by steel or iron caps.

Use of Intermediate Beams Where intermediate beams are used to support a floor in semi-mill construction, it is preferable that the beams should rest on the top of the girders direct. The width of the main girder is usually sufficient to give ample bearing for the ends of the beams in the bays on each side of the girder, even when the ends butt together. Common practice is to suspend intermediate beams between the main girders by the use of steel or iron stirrups or hangers. This practice undoubtedly lowers the cost of the side walls of the building owing to the diminished height of wall needed at each floor. This type of construction is not looked upon with favor by insurance underwriters. They claim that experience has shown that such stirrups or hangers are likely to prove hazardous during exposure to fire, either causing the heavy timbers to burn off quicker at the point of suspension in the stirrup or hanger, or allowing the beams to fall due to the failure of the metal stirrup or hanger itself.

The Crosby-Fiske Hand Book of Fire Protection contains the following comment upon this point:

> "Mill construction particularly in the Middle West, has suffered unfairly in reputation by reason of disastrous fire results, because buildings somewhat resembling this type have borne its name. They may have had floors and roofs of plank or wide spaced timbers, but in other particulars violated the principles of 'mill construction.' A common defect has been the use of exposed steel or iron stirrups to hold important floor timbers."

Floors Floors may be of dressed and matched or splined plank 3 inches (nominal) or more in thickness nailed direct to the girders. This type of floor is often called a "mill floor." If heavy loads are to be carried on long spans, planks 6 inches or 8 inches wide are set on edge close together, firmly nailed at each end and at about 18-inch intervals with 60 D. nails, alternating top and bottom, thus forming a "laminated floor." Each of these floors is covered with two or more thicknesses of waterproof paper or similar material and then by a top, or wearing floor laid at right angles to the direction of the underfloor. Material is surfaced on all sides and edges of plank beveled to serve as a finish on the ceiling below.

Where plank floors are laid flat, the boards should be two bays in length if possible and laid to break joints every 4 feet. With laminated floors, it may be difficult to obtain plank two bays in length. A strong and stiff floor will result if the planks are laid with the ends extending between centers of girders with one plank laid across the girder at frequent intervals (every sixth or eighth piece) to act as a tie in the floor. Or, by another method, the ends of planks should join at or near the quarter point of the span between girders, taking care to break joints in such a way that no continuous line across the floor will occur. Fig. 4 shows an instance of this kind in which the span between girders is 16 feet and the planks are 16 feet long. The method of lamination shown in Fig. 4 is as follows:

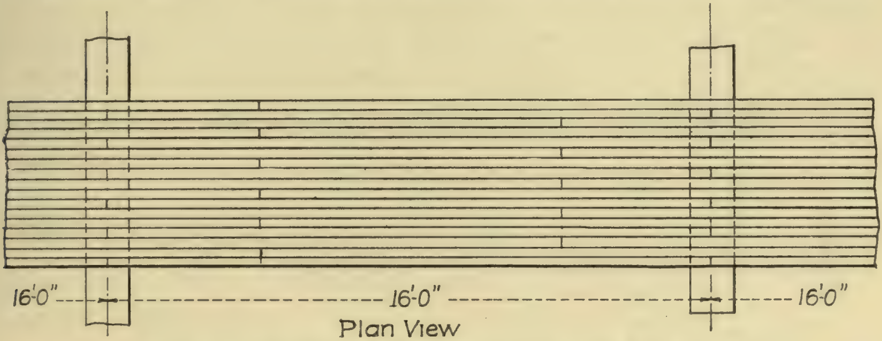
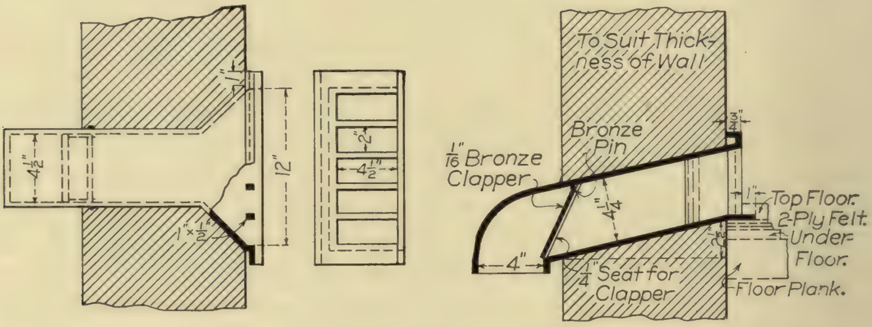


Fig. 4. Laminated Floor with Joints at Quarter Points.

> Every fourth piece of plank extends from center of girder to center of next girder. Next to this piece of plank, a second piece of the same length is nailed with the end spaced at a quarter point of the span between girders, thus allowing one end of the length to project three-fourths of the way across one span and one-fourth way across the other. The next piece of plank is placed over the opposite girder in the same manner that the previous is placed over the first girder. The lamination is completed by placing a length of plank from center of girder to center of girder as in the first case. Care is taken to see that each plank is nailed firmly in place with a tight joint between each piece of the floor.

In laying laminated floors, it is advisable to omit the last two planks at walls until after glazing and roofing have been completed. Then these spaces should be filled in close against the walls. It is often recommended that laminated floors be laid without nailing to the girders which support the floor, so that expansion in the floor due to dampness will not cause movement in the girders at the walls.

The top-floor may be of softwood or hardwood as use demands. Tongued and grooved flooring is used almost entirely. Square-edged flooring is easier to replace when repairs are needed, but wears less around nails, thus making an uneven floor. Some of the best buildings have a double top-floor, the lower part of softwood laid diagonally upon the plank under-floor, and the hardwood upper part laid lengthwise. This latter method allows boards in alleys or passages to be easily replaced when worn, and the diagonal boards brace the floors, reduce vibration, and distribute the floor load evenly. The top-floor should always be laid so that the length of the pieces is parallel to the direction of the traffic or trucking. Usually this is lengthwise of the building.



Horizontal Section

Vertical Section

Fig. 5. Scupper for Drainage of Floors.

If extra precaution is desired to prevent leakage of water through floors, the various layers of waterproof paper should be laid to break joints and each joint mopped with hot tar or a similar protective material. Also, floors may be given a pitch of 1 inch in 20 feet, and scuppers similar to that shown in Fig. 5 installed at floor level. These are ordinarily spaced from 20 to 40 feet apart along the wall.

The Associated Factory Mutual Fire Insurance Companies recommend the use of an approved elastic felt instead of waterproof paper. Their experience has been that felt properly laid gives better satisfaction in the long run. These companies recommend that a rough board floor be laid on top of the heavy plank floor, and that the waterproof felt be placed on this rough floor. A fairly smooth surface must be provided before the felt is laid, and any irregularity in the floor more than ⅛ inch deep should be filled up. Two layers of felt are used, breaking joints, and mopped with a sealing compound between the plies and on top of the felt. These companies recommend that the felt be turned up 6 inches at the posts and at the side walls. The hardwood top-floor is laid in the hot compound closely following the final mopping, so that the nails holding it down are tightly gripped.

At the walls the felt is protected by a counterflashing of galvanized iron, or by a base-board nailed in place with the joints between it and the floor covered by a quarter-round. Both the base-board and quarter-round should be kept free from the top-floor to allow the latter to move without breaking the corner of the turn-up in the felt. At the columns the felt may be protected by a base-board and quarter-round as at the walls.

Fig. 6 gives details of floor construction and flashing at side walls, as described above, and as recommended by the Associated Factory Mutual Fire Insurance Companies.

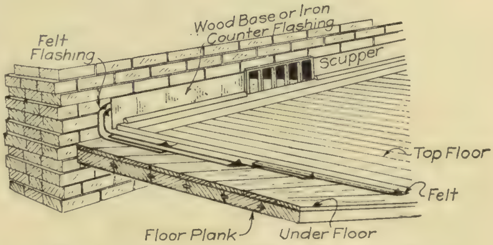


Fig. 6. Details of Floor Construction.

The following extracts from the Building Code Recommended by the National Board of Fire Underwriters are of interest in connection with the general design of floor timbers and floors:

"Wooden girders or floor timbers shall be suitable for the load carried, but in no case less than 6 in. either dimension, and shall rest on iron plates on wall ledges and where entering walls shall be self-releasing. Walls may be corbeled out to support floor timbers where necessary. The corbeling shall not exceed 2 in.

"So far as possible, girders or floor timbers shall be single stick.

"Where wooden beams enter walls on opposite sides, there shall be at least 12 in. of masonry between ends of beams, and in no case shall they enter more than one-quarter the thickness of the wall.

"Width of floor bays shall be between 6 and 11 ft.

"The practice in mill-construction of supporting the ends of beams on girders by means of metal stirrups or bracket hangers is objectionable. Experience has shown that such metal supports are likely to lose their strength when attacked by fire and so cause collapse.

"Floors shall be not less than 3 inches (2¾ inches dressed) flooring laid crossways or diagonally. Top flooring shall not extend closer than ½ inch to walls so as to allow for swelling in case floor becomes wet. This space shall be covered by a moulding so arranged that it will not obstruct movement of the flooring.

"Waterproofing shall be laid between the planking and the floor in such manner as to make a thoroughly waterproof floor to a height of at least 3 inches above floor level. When there are no scuppers, the elevator or stairwells may be used as drains for the floors, in which case the waterproofing material need not be flashed up at these points.

"All exposed woodwork in exterior construction shall be planed smooth.

"Pipes or conduits extending through floors shall be fitted with metal thimbles and made watertight to a distance of 3 inches above floor.

"All floors shall be arranged to drain to elevator well or some other point where minimum damage will result from water. It is recommended that, where feasible, floors be built with a slight pitch (about 1 inch to 20 feet) and have proper scuppers or drain pipes.

*"Two thicknesses of waterproof paper or its equivalent to be laid between the planking and the flooring in such a manner as to make a thoroughly waterproof floor to a height of at least 3 inches above floor level. If the paper itself is waterproof, the joints should be swabbed with tar, pitch, or their equivalent and overlapped at least 2 inches. If the paper is not waterproof, the entire surface of the lower layer to be swabbed with tar, pitch, or their equivalent and the upper layer placed on the lower while hot. Waterproofing paper to be flashed up at least 3 inches above floor openings and protected with mop board."

Fig. 7 shows an interesting point in connection with the erection of the framing in a mill construction building where laminated floors are used. This building was put up during cold weather, and the temperature was considered to be too low for laying brickwork properly. In order not to hinder the progress of the structure, it was decided to go ahead with the framing of the floors and follow later with the walls. Supports similar to those shown at the end of the girder in Fig. 7 were used throughout each story of the building above the brickwork already placed. The posts were supported in place by braces at the cap to prevent them from falling sideways, and in the opposite direction by the girders themselves. The ends of the flooring at the walls were supported by a temporary plate which could be easily removed after the final wall support was in place.

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*Uniform Requirements.

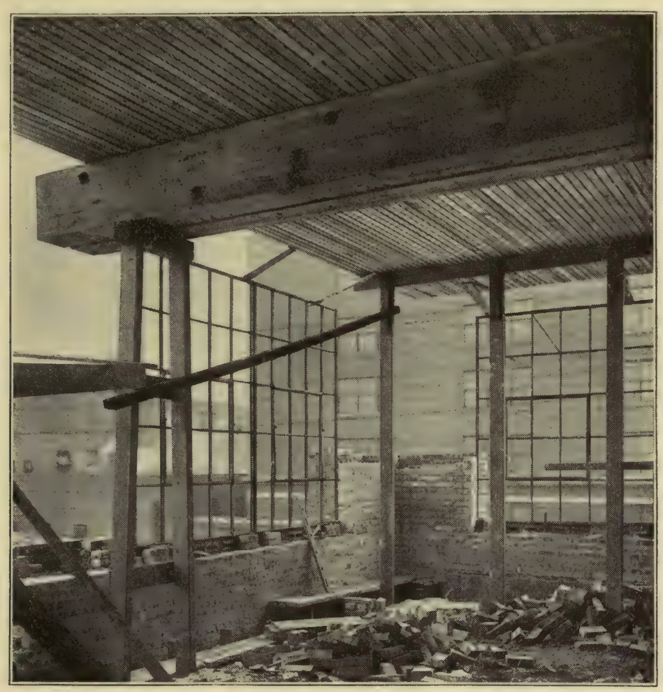

Fig. 7. Framing and Floors in Place in Advance of Walls.

Basement Floors Creosoted wood block floors for basements or for shop floors give excellent service and are easy for workmen to stand on. A floor of this type made of blocks well seasoned before treatment and laying, having the joints made with an approved cement or pitch filler, should last twenty years or more. Seasoning prevents shrinkage in the blocks after laying where used indoors. This is the opposite condition to that met in outdoor work. In the creosoting, an empty cell treating process, with five to eight pounds of oil per cubic foot, gives an excellent floor at moderate cost. When not subject to moisture or water soaking, etc., the blocks can be laid with close joints. Under moist conditions, a ⅛-inch joint closed with pitch is advisable. A good specification for a wood block floor is as follows:

In wet ground, first spread a thoroughly compact layer of cinders or gravel about 6 to 12 inches deep as the sub-foundation. Then place a 4-inch layer of Portland cement concrete. A ½-inch layer of sand and cement grout is spread on top of the concrete and smoothed preferably with a template until level to serve as a bed or cushion for the blocks.

Wood blocks may be used for upper floors if desired by placing under them two layers of paper laid in pitch, bedding the blocks in hot pitch and filling the joints with the same material.

A good basement or shop floor is made by laying a wood wearing surface on a base consisting of concrete and coal tar which contains from 20 to 25 percent of creosote oil. Such a floor is made by first spreading a 4-inch layer of screened gravel or stone not larger than 2½ inches mixed with tar. The tar is heated to 200° F., and enough used so that the mixture will be compact when rolled. The sand and gravel should be well heated before the tar is added. Often a 4 to 6-inch base of Portland cement concrete takes the place of the tar concrete. When cement concrete is used, it should be given a coat of tar before the top course is laid. A layer of tar and sand mixed in the proportion of fifty or sixty gallons of tar to each yard of sand and heated to 225° F. is spread over the base to a depth of 1¼ inches, and plank 3 inches thick is laid directly over this top coat while it is still warm and before it sets. The plank is then tamped into place, toe-nailed together, and a top or wearing floor laid on the plank.

If it is desired, an ordinary concrete floor may be used in basements. Such a floor has a base similar to that described for the block floor, covered with a layer of 1:2:4 Portland cement concrete 4 inches to 6 inches thick and finished with a wearing coat of cement and sand. This top coat is usually from 1 inch to 2 inches thick and composed of a 1:2 mixture of cement and sand. Top should be kept wet for at least ten days after laying.

Floor Loads, Working Stresses, Etc. Allowable floor loads, working stresses to be used in design, weights of merchandise, and weights of timber will be found in a separate section at the end of this bulletin.

CHAPTER IV.

POSTS OR COLUMNS.

General Construction The posts or columns in mill construction serve as interior supports for the floor and roof girders and carry the load to the foundations. Each set of posts should extend from roof to foundation without offset, passing through each floor between the ends of the girders for that floor, and resting upon a metal cap on the top of the post of the floor below. The ends of posts should be squared and bear evenly upon the plate of the post cap. At the foundation or pier, the squared end of the timber post should rest on a metal plate placed on top of the pier a little above the level of the basement floor to prevent contact with dampness from the masonry or concrete. A preservative treatment applied to the ends of the post is advisable if dampness is likely to be present.

Post Caps and Pintles The general alignment of the columns is preserved by the floor and roof girders which rest upon side brackets projecting outward from the post cap. Figs. 8 to 10 show a few of the types of metal post caps which are in use in different parts of the country.

Fig. 11 shows a type of pintle and post cap which is used to a considerable extent in the New England States and is recommended by the Associated Mutual Fire Insurance Companies. It should be noted that where no straps are used on the girders, or where post caps without projecting

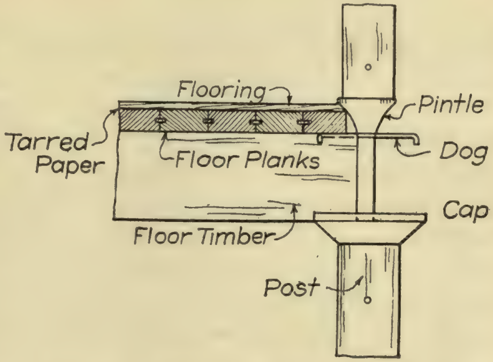

Fig. 11. Pintle and Post Cap Type of Construction.

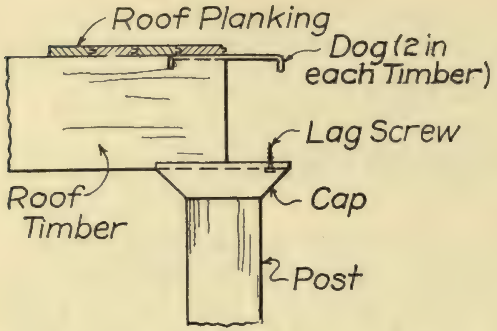

Fig. 12. Framing at Roof.

sides are used, the girders are tied together longitudinally by 1-inch iron dogs placed as shown in Fig. 11. The detail at the roof where this type of construction is used is shown in Fig. 12.

The supporting plate on a post cap should be of such size that the girders will have a bearing of at least 5 lineal inches at each end, and the end of the plate should not extend more than 6 inches beyond the post.

Minimum Sizes Minimum sizes of timber for columns vary from 8 inches by 8 inches in top story, to 10 inches by 10 inches in any story, depending upon the ordinances of different cities. In any event, the area of cross-section should be sufficient to carry the load with a suitable factor of safety, and also provide fire resisting qualities. Square posts of a given size are nearly one-fourth stronger than a round post turned from the same timber.

Many ordinances in a measure control the size of posts by limiting the length of a post of a given side dimension. The Chicago Building Ordinances state that no timber post shall be longer than thirty times its least side dimension.

Post Details While there is a difference of opinion as to the value of boring posts, some insurance engineers recommend the practice of boring a 1½-inch diameter hole longitudinally through the center of the stick, with ½-inch vent holes at top and bottom. It is claimed that this precaution will prevent damage from dry rot in timber which has not been thoroughly seasoned before using. This should not serve as an excuse for using material fresh from the saw, since it is advisable that none but suitably seasoned timber of the best quality be used in any part of the framing.

Edges of posts should be rounded or chamfered to prevent easy ignition in case of fire. The post should be left square

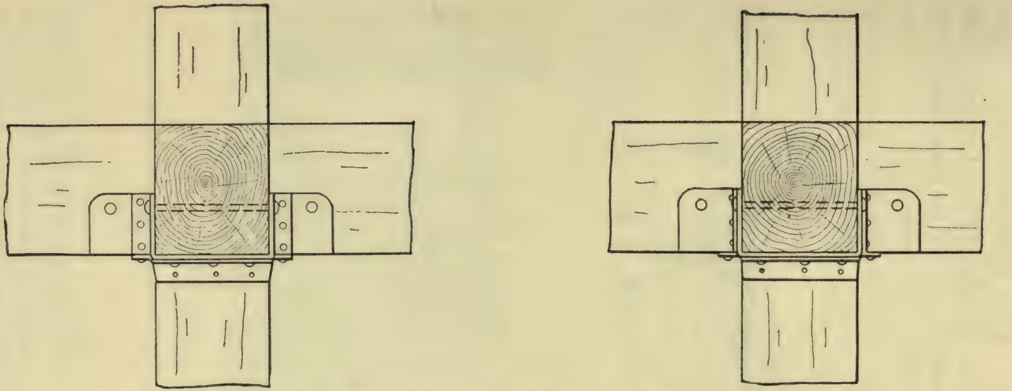

Fig. 9b. A Four-Way Steel Post Cap.

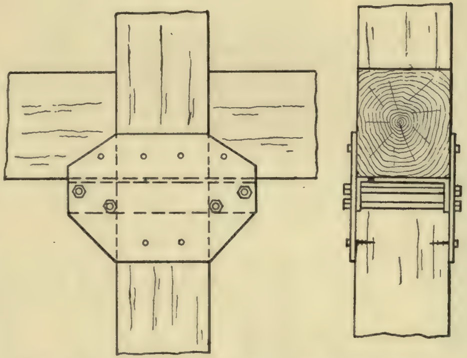

Fig. 10. Steel Post Cap with Side Plate.

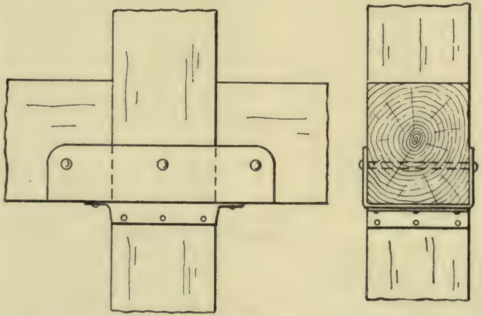

Fig. 9a. A Two-Way Steel Post Cap.

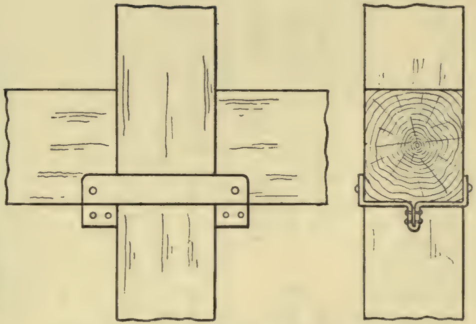

Fig. 8. Steel Post Cap with Fin.

near top to receive the post cap, and also at the bottom where it passes through the floor.

Finish on Woodwork Girders, beams, floors, or posts should not be painted, oiled or plastered until they have become fully seasoned. This time is usually between two and three years. Wood finish without concealed spaces may be used with safety in offices, etc., but varnish and shellac finishing coats are called objectionable by insurance underwriters. Ordinary paint is not objectionable.

Interior of Semi-Mill Construction Building.

(Lockwood, Greene & Co., Engineers, Boston.)

Calculations for Posts The method of determining the amount of load carried by a given post, percentage of load from posts above carried by the lower posts, formulas for design of posts, and unit compressive strength of various kinds of timber will be found in an appendix to this bulletin.

CHAPTER V.

ROOFS.

General Construction Roofs in mill construction buildings are usually flat with a slight pitch of 1/4 inch to 3/4 inch to the foot. They are framed in the same manner as are the floors, the under side of the roof forming the ceiling for the top story. If a plastered ceiling is necessary, the metal lath which is to hold the plaster should be fitted around the girders and against the roof boards in such a manner as to leave no spaces between the plaster and wood. If plastering is to be used in contact with the timber, it should be of plain lime mortar without the skim coat of lime putty. The rough plaster is sufficiently porous to permit seasoning to continue if necessary.

Roofs should be covered with an incombustible material. Composition, slag or gravel roofing is used to a large extent for this purpose.

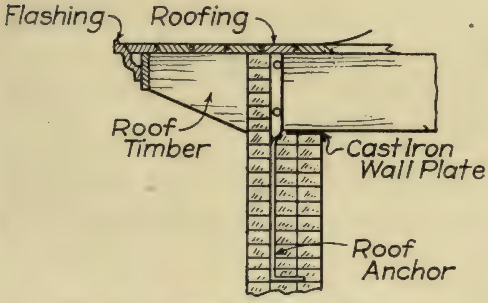

Fig. 13. Detail of Wood Cornice.

The necessity of a cornice is questionable, even from an architectural standpoint. It is a constant source of expense for maintenance and is likely sooner or later to become dangerous and fall without warning, due to the failure of concealed members. Providing a cornice is to be used, the open wood type shown in Fig. 13 is recommended by the Associated Factory Mutual Fire Insurance Companies, but an incombustible cornice is advisable when there is exposure from neighboring buildings.

Girders and Roof While the size of the girders to support the roof will not need to be as large as those for supporting the floors on account of the lighter loads carried, the minimum sizes of material permitted will control the size of girders to be used. In many cases this dimension is regulated by the local building ordinances, and an inspection of such ordinances will show that sizes vary in different communities. From the standpoint of fire protection, the smallest roof girder that should be used is at least 6 inches in either dimension, but the common building regulation is that such girders should be at least 6 inches thick and have a cross-section area of at least 72 square inches. This same regulation in regard to minimum sizes should apply to beams in semi-mill construction, as well as to the girders in standard construction.

The size of the bays in the roof will be determined by the size of the bays of the floors below.

In many cases a roof of semi-mill construction type is placed on a building in which all of the floors are of standard mill construction, or of laminated type. This design is not necessary, since a certain minimum thickness of roof plank is demanded regardless of the load to be carried, and the thickness of 3 inches commonly specified is sufficient to support ordinary roof loads with the lengths of span between girders commonly found. A simple calculation will show this point to be true, especially where a good grade of lumber is used. Roof plank 3 inches in thickness may be tongued and grooved, but with a thickness of 4 inches and over splined plank should be used.

Both roof timbers and planks should be self-releasing at walls, and have exposed surfaces planed.

Roof Covering One of the most satisfactory types of roofing is of the built-up variety, where layers of felt saturated with tar are nailed down, and by the use of asphalt or pitch protected and cemented together.

The following specification quoted from a Report of the American Railway Engineering Association gives what is considered to be good practice in the construction of a flat built-up roofing on wood sheathing:

SPECIFICATION FOR FELT, PITCH AND GRAVEL OR SLAG ROOFING OVER BOARDS

INCLINE.—This specification should not be used where roof incline exceeds three (3) inches to one (1) foot.* For steeper inclines modified specifications are required.

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*Modern practice tends to reduce this slope to 2 inches to 1 foot.

Specifications

Roofing.—First, lay one (1) thickness of sheathing paper or unsaturated felt, weighing not less than five (5) pounds per hundred (100) square feet, lapping the sheets at least one (1) inch.

Second, lay two (2) plies of tarred felt, weighing fourteen (14) to sixteen (16) pounds per hundred (100) square feet, lapping each sheet seventeen (17) inches over the preceding one, and nail as often as is necessary to hold in place until remaining felt is laid.

Third, coat the entire surface uniformly with straight run coal-tar pitch.

Fourth, lay three (3) plies of tarred felt, lapping each sheet twenty-two (22) inches over the preceding one, mopping with pitch the full twenty-two (22) inches on each sheet so that in no place shall felt touch felt. Such nailing as is necessary shall be done so that all nails will be covered by not less than two (2) plies of felt.

Fifth, spread over the entire surface a uniform coating of pitch, into which, while hot, imbed not less than four hundred (400) pounds of gravel or three hundred (300) pounds of slag to each one hundred (100) square feet. The gravel, or slag, shall be from one-quarter (¼) to five-eighths (⅝) inches in size, dry, and free from dirt.

Flashings.—Flashings shall be constructed as shown in detailed drawings.

Labels.—All felt and pitch shall bear the manufacturer's label.

Inspection.—The roof may be inspected before the gravel or slag is applied by cutting a slit not less than three (3) feet long at right angles to the way the felt is laid.

N. B.—To comply with the above specifications, the material necessary for each one hundred (100) square feet of roof is approximately as follows: 100 square feet sheathing paper, 80 to 90 pounds tarred felt, 120 to 160 pounds straight run coal-tar pitch, 400 pounds gravel, or 300 pounds slag.

In estimating felt the average weight is practically fifteen (15) pounds per one hundred (100) square feet, and about ten (10) per cent extra is required for laps.

In estimating pitch the weather conditions and expertness of the workmen will affect the amount necessary for the moppings and to properly bed gravel or slag.

The sheathing paper or unsaturated felt is placed on the bottom next to the roof boards, mainly to keep any pitch which might penetrate the two-ply felt above it from cementing the roofing to the sheathing. It also is of value in preventing the drying out of the roof through open joints from below. The saturated felts should be nailed where there is any chance of disturbance of the roof from underneath by wind, and also enough to hold it in place while laying. The practice in regard to nailing varies in different parts of the country, but the fewer nails the better, so long as the roof is held in place.

The contract price for this roof should not be less than the cost of the materials specified, plus the cost of laying and a reasonable amount for profit. Thorough inspection of materials and workmanship is recommended.

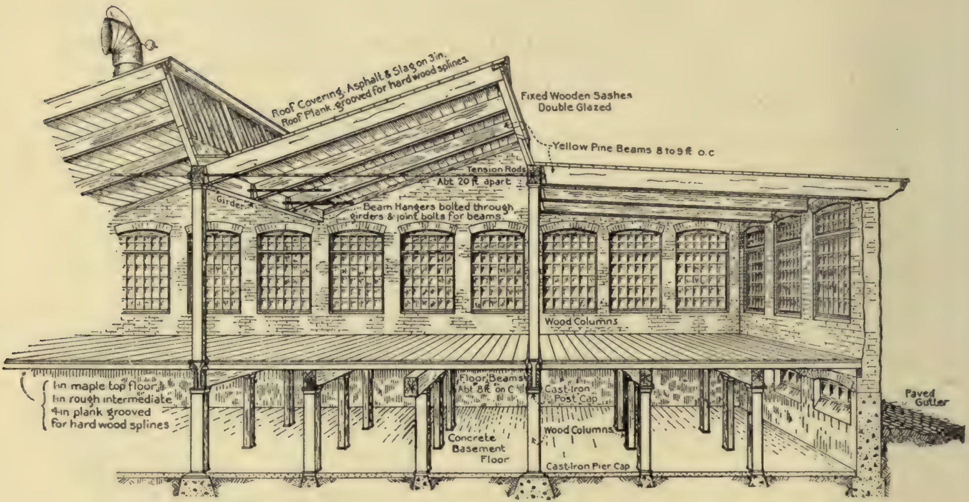

Fig. 14. Saw-Tooth Roof of Timber Construction.

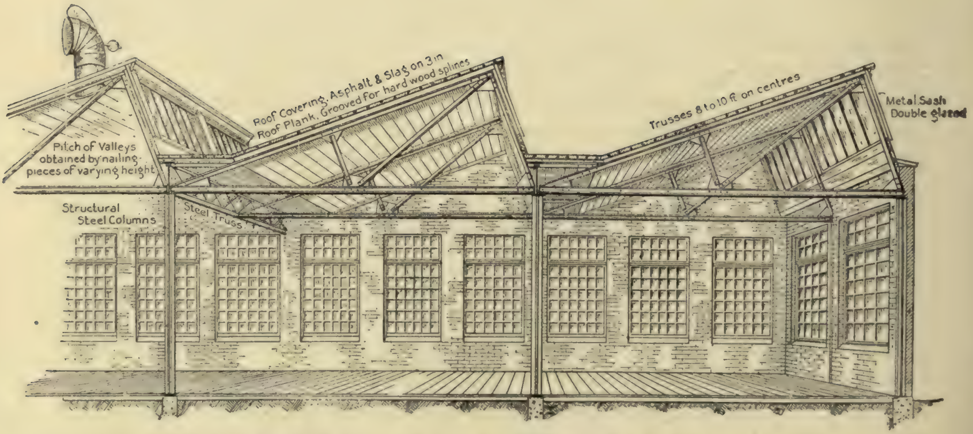

Fig. 15. Steel Framing with Plank Roof.

Trussed Roofs In many types of commercial buildings open spaces without posts are desired. This condition is very likely to exist in manufacturing plants where large areas of clear floor are necessary for the movement of machinery or assembling machine parts. In such buildings the posts are taken out and roof trusses used to span the opening. Trusses are ordinarily placed from 8 feet to 20 feet on centers with 3-inch plank spanning the distance between the trusses as in standard mill roofs, or resting on purlins spaced not less than 8 feet on centers and running from truss to truss. It is advisable to have the purlins supported at the joints of the trusses to prevent bending in the members of the top chord. Other details of the roof are similar to those described above.

Saw-Tooth Roofs Where a saw-tooth form of roof is needed, the roof planks are supported by heavy timber beams, or by steel trusses, spaced from 8 feet to 10 feet on centers, and in turn carried by timber girders, trusses, or columns. In fact, the design of the roof planking itself varies but little from that used in the ordinary flat roof of standard mill construction. The detail of the supporting members will vary with the type used. Figs. 14 and 15 show two forms of saw-tooth roofs, one wholly of timber construction and the other of timber and steel. Fig. 16 shows a detail of the valley used in timber construction, such as shown in Fig. 14. These details are as recommended by the Boston Manufacturers Mutual Fire Insurance Company.

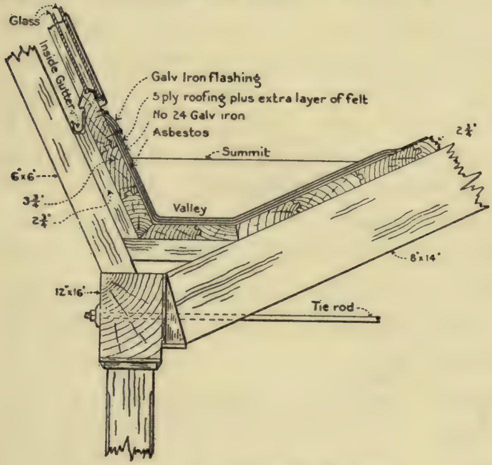

Fig. 16. Detail of Valley.

CHAPTER VI.

FIRE PROTECTION.

A building can be protected from damage by fire from exterior sources by the use of fire-resisting shutters or wire glass in steel or hollow metal frames at the windows and openings, together with an incombustible cornice. Thick party walls, and parapet walls extending not less than 3 feet above the roof line form additional safeguards. Fires occurring within a building may be confined to a limited space by the use of fire walls, heavy timber floors without openings, enclosed stairways, automatic fire doors, protected openings into power and elevator shafts, protected windows near angles of the building, and incombustible interior walls which extend through the roof for a distance of 3 feet or over. The installation of an automatic sprinkler system of a design capable of reaching fire in any part of the building and supplying water in sufficient quantities is always advisable. Not only does such equipment serve as a protection from spread of fire, but it allows also a lower insurance rating on the building and contents. A dependable water supply is a necessity, and at least two independent sources are generally provided from gravity tanks, pressure tanks, pumps or high pressure street service.

Standpipes and hose located in stair towers or other protected places offer additional safety. A steamer connection on exterior of building is advisable.

Suggestions for the typical installation of sprinklers will be found on page 47.

Details in regard to the design of sprinkler systems and the arrangement of other protective apparatus are covered by a special bulletin issued by the National Lumber Manufacturers Association.

Stairways and Elevator Shafts Vertical openings through buildings have proved to be the weakness which led to the destruction of many otherwise good buildings. All doors and openings into stairways or elevator shafts and between units should be provided with fire doors. These doors should be made automatically self-closing by means of springs or weights and chain. Doors should never be blocked open, even temporarily. Where it is necessary to allow a door into a stairway to stand open, it should be held open by some simple automatic mechanism, arranged to release the door and allow it to close when fire occurs. Stairs may be of timber construction if the building is equipped with an automatic sprinkler system and stairways are enclosed by fireproof walls.

The proper design of walls for stairways and elevators is discussed in Chapter II.

Shutters and Wire Glass For severe or dangerous exposures it is desirable that all openings in exterior walls should be protected by tin clad, solid steel, or sheet-metal shutters. Shutters should overlap the sides and top of the window opening or close into the opening, so as to prevent cracks through which fire might pass. Modern practice has determined that steel or hollow metal wire glass windows are substantial in construction, and practical under most conditions of exposure. Such windows furnish a fair degree of resistance to fire, and where the exposure is not severe, they will prevent the spread of fire from one building to another, or one story to another in the same building. Two types of windows are commonly used—"steel sash" made of rolled steel sections, and hollow metal sash and frames made of galvanized sheet metal or copper of suitable gauge, reinforced by steel bars and angles. Wire glass is used in both of these types.

The fire-resisting qualities of mill construction are exemplified by the following extract from "Fire Prevention and Fire Protection" by J. K. Freitag:

> "A wonderful illustration of the slow-burning qualities of slow-burning construction was afforded by the fire which destroyed the storage warehouse of the George Irish Paper Corporation, at Buffalo, N. Y., Jan. 16, 1911. The building was six stories in height, 70 by 200 feet in area, and of mill construction without sprinklers or other special fire protection equipment. Because of the type of construction of the building, and the great weight of the paper stock known to be stored therein, the firemen flatly refused to enter the structure, so that the flames were fought merely from the outside. The fire raged for upwards of 80 hours and was the longest fire known in the City of Buffalo, yet after 36 hours of fire the front windows in the top story were practically intact. No better example of 'slow-burning' construction could possibly be given."

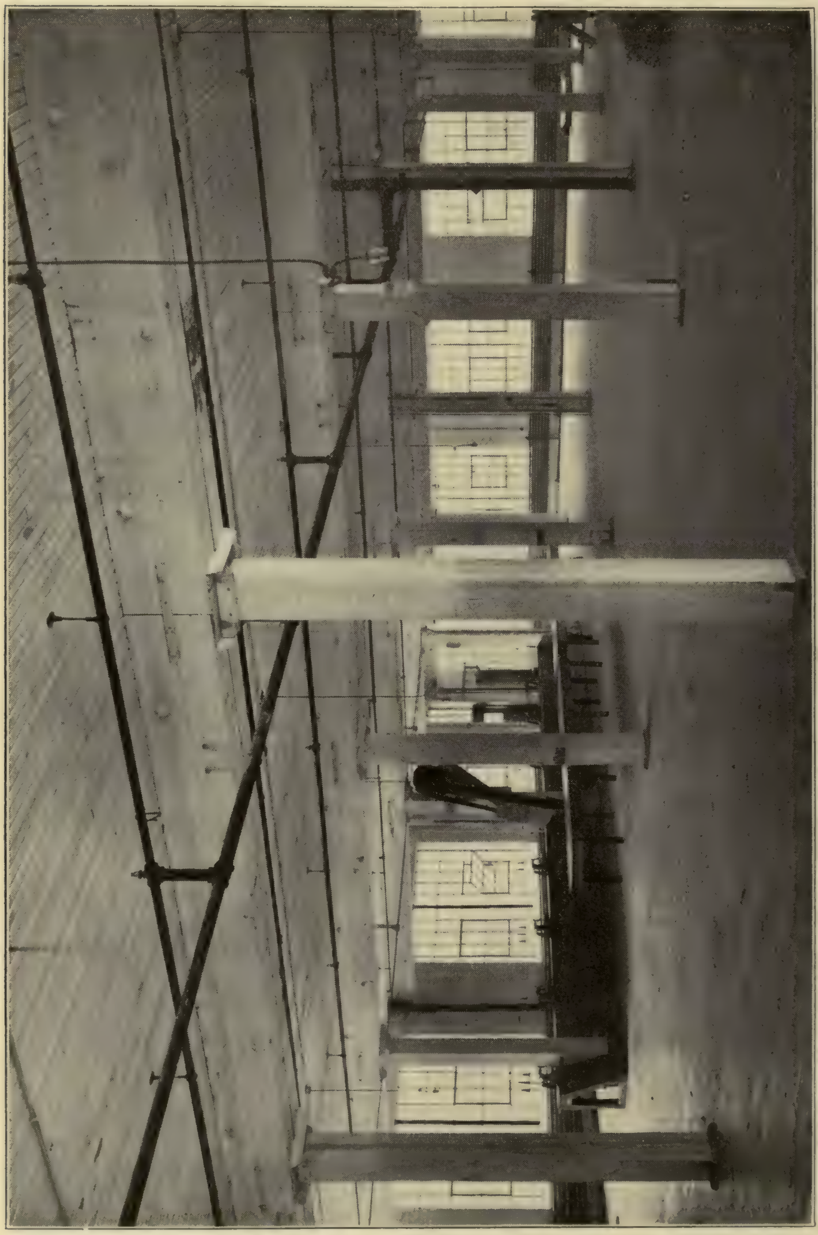

Fig. 17. Interior of Modern Mill Construction Building.
(Central Bag Mfg. Co., Central Mfg. District, Chicago. S. Scott Joy, Architect.)

CHAPTER VII.

COST OF MILL CONSTRUCTION BUILDINGS.

One of the important advantages of mill construction is the relatively lower cost when compared with other types of buildings. This feature has been recognized from the early days of this type of construction. With the advance in the cost of building materials as a whole, the relative difference between timber, steel and concrete has changed slightly in favor of concrete, but the advantage as a whole is still on the side of mill construction. The old custom of using girders 45 feet in length and spanning three bays of a building has passed, but the same strength is now obtained by using shorter lengths of larger material of a high bending strength. Large timbers of great strength in proportion to weight are obtainable in all markets, and there is an ample supply of all sizes and grades in several different species.

Mill construction buildings vary in cost with the locality in which they are built. The cost per cubic foot will vary from 5c to 12c, with an average of about 8c. These costs are without the consideration of plumbing, heating, elevators or other equipment. Such extras will increase the cost per cubic foot by 1c to 2c. The corresponding cost per square foot of floor area of building is from 50c to $1.50, with an average cost of about 90c. In order to obtain these reasonable costs, standard lengths and sizes of timber should be used, or else an extra amount will have to be charged for specials. The cost of such buildings may be kept to a minimum by careful decision in choosing length of spans and areas of floors. Each girder and floor plank should be used to its full capacity, as determined by the load rating of that floor. Areas of floors should be such that fire walls will not be needed between the different parts of a floor, thus keeping down the cost for protection of openings between rooms. A careful choosing of the sizes of bays will aid in the design of the sprinkler piping by making one or two lines of sprinklers do the work where more piping might be needed in case the spans were chosen without attention to this detail.

An investigation conducted by J. Norman Jensen, Architectural Engineer, Chicago, showed that the range of costs in the three types of construction is so great that no generalization can be made. By comparing the costs of a large number of different types of construction the following conclusions were reached:

> "With column spacing not exceeding 16 feet, mill construction buildings designed for 100 pounds per square foot live load cost 20% less than concrete buildings; for 150 pounds per square foot live load, 15% less, and for 200 pounds per square foot live load, about 10% less. When the live load was 350 pounds per square foot or over, a concrete building was the cheaper."

This investigation showed also that when the column spacing in any building is greater than 16 feet, the relative economy of mill construction disappeared. It has been found, however, that a column spacing of 16 feet is ample for the majority of buildings devoted to manufacturing or other mercantile businesses. For most light manufacturing buildings a live load of 100 lbs. per square foot is sufficient, and for a large percent of the buildings used for storage purposes, 200 lbs. per square foot is all that will ever be placed on the floors.

An investigation in regard to the cost of insurance on mill construction, steel and concrete buildings showed that in ordinary lines of business the rate of insurance on a sprinklered mill construction building and contents runs about 25 cents per $100.00, while the rate on a concrete building and contents unsprinklered runs about 45c. The rate on both types of construction sprinklered is about the same, but the cost of installing the sprinkler system in the concrete building may make the total cost higher in comparison with a mill construction building.

The unit cost of a building varies considerably with the height of the structure. In connection with this point the following extracts from "Mill Buildings" by H. G. Tyrrell is of interest:

> "Mill construction buildings of one and two stories cost more than buildings of three to five stories, the last being about 15% less per square foot of gross floor area than when all floor space is on the ground. For light products, it is, therefore, economical to make manufacturing buildings not less than three stories in height, for not only is the building itself less expensive, but it also occupies smaller ground space. The only possible reason that might cause the owner of a building for light manufacturing purposes to select one floor in preference to three or more would be the relative con-

venience and economy of carrying on the work on a single floor. Records of certain factories show that the cost of labor is from 5% to 10% less when work is all done on a single floor rather than on several floors."

A further comparison of the cost of wood, reinforced concrete and steel buildings is made by Mr. Tyrrell in his book "Engineering of Shops and Factories," as shown by the following extracts in which A is the greatest cost and G the least:

"Building types, arranged in order of their relative first cost, are as follows:

A. Complete steel frame, fire-proofed, with curtain walls and plank floor.

B. Interior steel frame, fire-proofed, with solid brick walls and plank floor.

C. Complete steel frame, fire-proofed, with curtain walls and reinforced concrete floors.

D. Interior steel frame, fire-proofed, with solid brick walls and reinforced concrete floors.

E. Entire reinforced concrete building.

F. Part interior steel frame, not fire-proofed, with solid brick walls and wood mill floors.

G. Entire wood mill construction.

"In comparing the first cost of buildings in wood mill construction and in reinforced concrete, it will be found that their relative cost varies with the location, size of building and the floor loads to be sustained. In the Southern states, or other regions where timber is abundant and cheap, wood construction will often cost 25% to 30% less than reinforced concrete, while in districts where wood is scarce, the two types may be nearly equal. The comparison depends also on the size of the building, for large ones have often been found to cost about the same in either material, and small ones are sometimes more expensive by 30, 40 or 50% in reinforced concrete than in wood. The required floor capacity also affects the comparison. Light loads with long spans are cheaper in wood mill construction than in reinforced concrete, the cost of the two types being nearly equal in large buildings with 200 pounds imposed load per square foot, and column spacing of 18 to 20 feet. With loads of 300 to 500 pounds per square foot concrete becomes cheaper, and the saving increases rapidly with greater loads of 1,000 to 1,200 pounds per square foot."

The following extracts taken from an address delivered before the Portland members of the West Coast Lumbermen's Association by C. J. Hogue, Architect, Portland, Oregon, are of interest since they provide comparative data from that section of the country.

"As a result of twelve years' experience in New England I saw reinforced buildings (I am speaking from the standpoint of an engineer), concrete buildings constructed for within 5 to 15 percent of the cost of mill construction, and structural steel buildings at 10 to 25 percent additional cost. Of course in the cheaper types of wood construction there were more differences than with an engineering type. At that time the cost for mill constructed buildings would have shown a greater difference than I found for reinforced concrete. As a matter of fact we could not obtain low enough rates in insurance on sprinklered reinforced concrete buildings over sprinklered mill construction to pay the difference in the interest on cost of the two types of buildings.

An Example of Mill Construction in Chicago.
(F. E. Davidson, Architect and Engineer, Chicago.)

"Since my return to Portland I have been ostensibly practicing economy, so I can not give you the best of comparisons from my experience. But in the recent effort to relieve building conditions in the inner fire district, which resulted in eliminating one-third from the inner into the outer district, we took comparative figures on two buildings, one mill constructed and one of reinforced concrete. The two buildings were to cover an area of 100 by 100—plastered throughout, as if they were to be used for retail stores. The figure we received, without heating, lighting, plumbing and elevator, for mill construction was $27,135 against $37,651 for the reinforced concrete building, an additional cost of 37 percent. To those figures, add $6,000 to both buildings for plumbing, etc., and the additional cost of the reinforced concrete building was 31.7 percent more than the cost of the mill constructed building. This is because lumber is cheaper in the West than it is in the East, and cement, sand and gravel are much more expensive.

"Now the best comparison of safe types of fire resisting construction can perhaps be shown by the comparative insurance rates—from the judgment of men whose business it is to study this question. We in Portland have secured comparative insurance rates—assuming occupancy of a furniture store and the rate on the wood construction building was 47 cents and on the fireproof building 35 cents and with sprinklers the comparison was 28 cents on the mill and 21 cents on the fireproof. The rate was made on the building, not on the contents. The rate for the mill constructed building, sprinklered, 28 cents, was less than on the unsprinklered fireproof building, 35 cents.

"I also had copies of fire rates from the Chicago Board of Fire Underwriters, assuming a machine shop occupancy. The rate on a building not sprinklered, mill construction, was $1.11, as against 24 cents for fireproof construction; and sprinklered, 15 cents for mill construction as against 14 cents for fireproof material. The comparison between the sprinklered mill construction building shows 15 cents as against 24 cents for the non-sprinklered fireproof building; and where both are sprinklered only 1 cent difference, 15 cents for the mill construction and 14 cents for the fireproof. On the contents, the rate on non-sprinklered mill construction was $1.36 as against 64 cents for the fireproof; the rates on the contents of sprinklered building were 30 cents for the mill as against 26 cents for the fireproof building. The comparison there for the sprinklered mill constructed is 30 cents as against 64 cents for the non-sprinklered fireproof building. This shows clearly that a sprinklered mill construction building is a safer risk from a fire insurance standpoint than one of non-sprinklered fireproof construction.

"The sprinklered mill constructed building is safer both as to building and contents than is a fireproof building, non-sprinklered. In the same way a mill constructed building with properly constructed stairways and elevator shafts is safer as to contents than the non-sprinklered unprotected stairway of a fireproof structure. Another thing is the temperature which runs from 1,000 to 1,200 degrees as compared to 1,800 degrees in fireproof non-sprinklered buildings. The steel columns almost invariably buckle early in the game and are of no further support to the building.

"I believe, from my experience in both kinds of construction, that the mill constructed building, masonry walls, wire glass windows, equipped with a sprinkler system, would have almost as great effect in stopping a conflagration as if the interior was of so-called fire-proof construction, that is, incombustible materials."

CHAPTER VIII.

STANDARD MILL CONSTRUCTION.

This section illustrates the advantages of well-designed buildings and protective apparatus in the prevention of heavy losses by fire, as recommended by the Associated Mutual Fire Insurance Companies of New England, and shown in Report V, issued by the Insurance Engineering Experiment Station under direction of Boston Manufacturers Mutual Fire Insurance Co. Since this particular type of mill construction has been developed mainly to meet New England conditions, it follows that the references to the kind of timber apply more directly to the New England market than to other localities.

While modern practice as outlined in the earlier pages of this bulletin may vary in some details, this section serves as a summary. It also presents the subject from the standpoint advocated by the insurance companies responsible for the greater part of the development of this class of building.

This plate (Fig. 18) illustrates the best practice in construction of a storehouse more than two stories in height, intended for storage of raw stock or goods. The important features of the design, which should be kept in mind when applying them to special cases, are as follows:

Construction "The area of each compartment to be preferably 5,000 square feet but not over 10,000 square feet for non-hazardous storage; 5,000 square feet is the usual standard for cotton. The height of each story for cotton, or for other readily inflammable material, should be such as to permit the storage of but one bale on end—8 feet from floor to floor is generally sufficient. When designed for cased goods the height should be sufficient to take two cases, with 10 inches to 12 inches under the beams, in order not to impede the distribution of water from the sprinklers. Ample provision for passageways should also be made.

"The compartments should be separated from each other by solid brick walls and be accessible only from the elevator and stair tower, with the openings here protected by standard automatic sliding fire-doors. This will confine damage to the compartment in which a fire may start.

Walls "Brick walls should be at least 12 inches thick in the top stories and increased at the lower floors to support their additional load. The pilastered wall has many favorable features and may be preferred to the plain solid form.

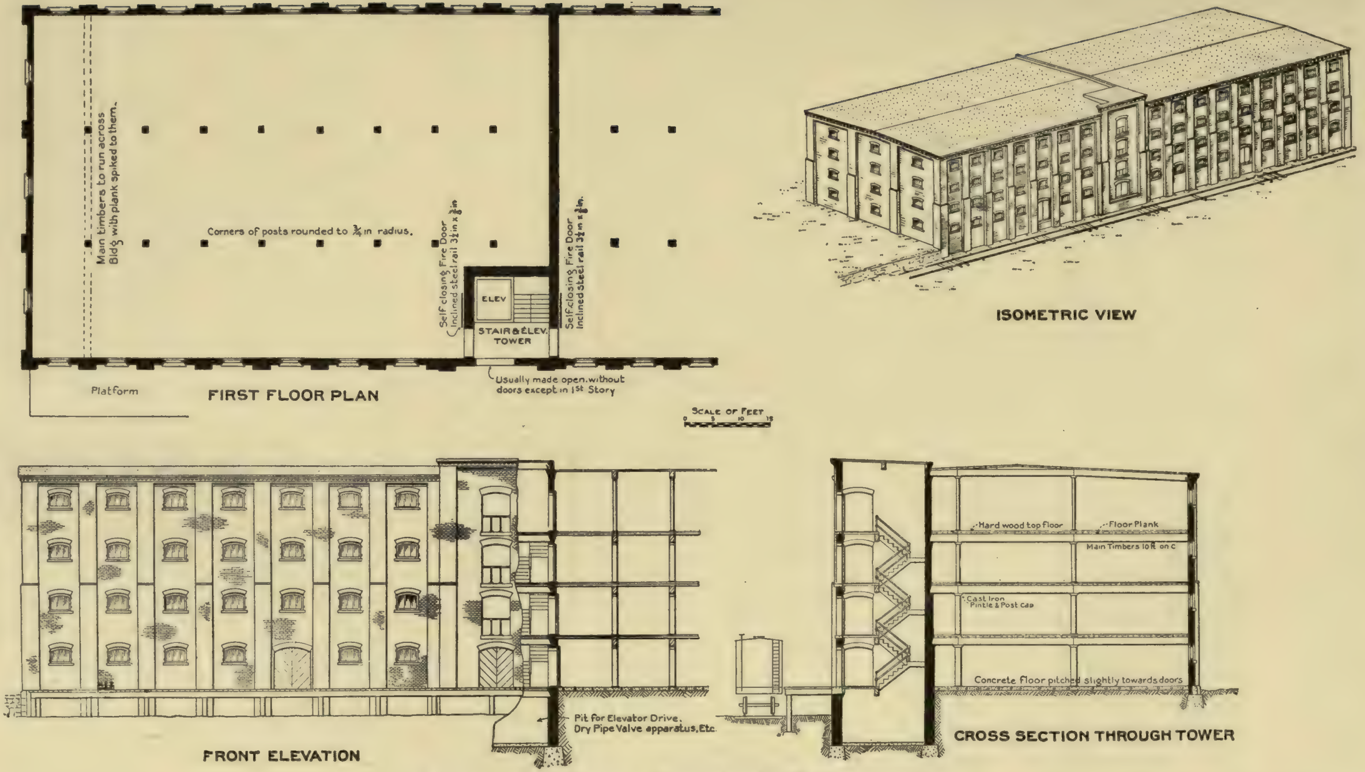
Main timbers to run across
Bldg with plank spiked to them.
Corners of posts rounded to ¾ in radius.
Self closing Fire Door
Inclined steel rail 3½ in x ⅝ in.
ELEV
STAIR & ELEV. TOWER
Self closing Fire Door
Inclined steel rail 3½ in x ⅝ in.
Platform
FIRST FLOOR PLAN
Usually made open, without doors except in 1st Story
SCALE OF FEET
0
5
10
15
ISOMETRIC VIEW
Hard wood top floor
Floor Plank
Main Timbers 10 ft on c
Cast Iron Pintle & Post cap
Concrete Floor pitched slightly towards doors
Pit for Elevator Drive, Dry Pipe Valve apparatus, Etc.
FRONT ELEVATION
CROSS SECTION THROUGH TOWER

Fig. 18. **Storehouse of Standard Mill Construction.**
(Boston Manufacturers Mutual Fire Insurance Company.)

"Window and door arches should be of brick; window and outside door sills and underpinning of granite or concrete.

Roofs "Roofs should be of 3 inch pine plank, spiked directly to the heavy roof timbers and covered with 5-ply tar and gravel roofing. Roof should pitch one-half inch to the foot. Conductor pipes should not pass through the building unless the storehouse is to be heated in winter. An incombustible cornice is needed when there is exposure from neighboring buildings. The fire wall should be carried 2½ feet above the roof, and provided with vitrified coping laid in Portland cement mortar.

Floors "Floors on each story in the tower should be about one inch lower than the floors in the adjoining compartment. The sills should be sloped to make up for this difference in level. The sill of the outside door in the tower should also be lower than the tower floor.

"Water on floors in the tower will ordinarily flow down the stair and elevator shaft, and arrangement of floor levels indicated above will ordinarily prevent water coming from an upper floor from flowing into one of the lower compartments, if it is escaping through the tower. Cast iron scuppers are advised and should be set in the brickwork at frequent intervals, so designed that they will carry away rapidly a maximum quantity of water from the floors of each compartment. Water-tight floors are always desirable and become a necessity in certain storehouses with valuable contents, but in three and four story storehouses are not usually considered essential. In higher buildings one or two floors are often covered with an inch of rock asphalt, properly applied and turned up around posts and at walls about 4 inches. Considerable care is necessary in constructing a water-tight floor if satisfactory results are to be obtained. All water will then pass out at the scuppers and no damage is caused on floors below. There must be no vertical openings through the floors except in the tower. Fire thus cannot gain access from one floor to another without burning through the solid plank floor.

"Floors should be of spruce plank 3 inches or 4 inches or more in thickness according to the floor load and should be spiked directly to the floor timbers. In floors and roof the bays should be from 8 to 10½ feet wide and all plank two bays in length laid to break joints every 4 feet and grooved for hardwood splines. The plank at the walls should be left out until the windows are put in, to prevent damage from swelling in case of rain.

"The top floor should be of maple or other close-grained hardwood. The floor and roof timbers should be of sound Georgia pine in single sticks, if possible, but if necessary to use double beams, they should be bolted together without air space between. Timbers should rest on cast-iron plates or beam boxes in the walls and on cast-iron caps in the columns. At least a half an inch air space should be left around all beams built into the masonry. Columns of Southern pine should be cut with their ends square with the axis.

"Windows may be of small area, but should be placed high in order to give the best light.

Protection "A standard equipment of automatic sprinklers should be installed throughout. In mild climates, and even under some conditions in cold ones, it is advisable to install a line of 1¼-inch steampipe overhead on each floor to provide sufficient heat to avoid freezing of the water in the sprinkler-pipes. If the building is not heated an air system with water controlled by an approved dry-pipe valve must be used, and all pipes must have ½-inch pitch per 10 feet back to main riser to insure proper drainage. A dry-pipe valve chamber may be located in the basement of the stair tower. The number of sprinklers in one dry-pipe valve should preferably not exceed 300, and 400 is the maximum allowed under the rules. By heating the storehouse the expense of installation and maintenance of the dry-pipe system is avoided, and in buildings of this substantial character only a very small amount is needed, as it is only necessary to keep the temperature above the freezing point.

Standpipes "Standpipes are often advisable in the stair towers of the higher storehouses, and provision should be made below frost for draining them in cold weather, with a readily accessible indicator post gate for controlling the supply in case of emergency.

"Water supply to the sprinklers and standpipes, as well as for such outside hydrants as may be needed should be of good capacity from two independent sources."

CHAPTER IX.

QUALITY AND KIND OF TIMBER USED.

In order to obtain proper service from mill construction buildings, it is most essential that a good quality of timber be used. The special requirements for timbers which constitute good quality deal with their strength and lasting power. The strength of any timber will be determined by its weight or density; the size, quality and distribution of knots, and the presence or absence of defects. The density or dry weight of wood may be regarded as a measure of its strength. Taking timbers of yellow pine or Douglas fir as types, it should be noted that "each annual growth ring is composed of a band of dense, heavy, dark summerwood and a band of lighter, softer springwood. The greater the proportion of summerwood, the greater the weight and strength of the timber. The principle, referring to the number of growth rings and the proportion of summerwood as a measure of density and hence of strength, applies to all woods in which there is a marked contrast between the character of the springwood and the summerwood."*

As a result of extensive investigation made by the United States Government and the American Society for Testing Materials, a rule was adopted in 1915 which clearly specifies the manner for determining two classes of structural yellow pine timbers, one a high-grade quality called "dense pine" and the other grade of lower strength value called "sound pine." The specifications for these classes‡ will be found in a booklet issued by the Southern Pine Association, New Orleans, La., entitled, "Southern Yellow Pine Timbers Including Definition of the Density Rule." A similar rule is now being prepared for Douglas fir, and in the absence of any accepted standard for Douglas fir, it will be safe to use the rule as drawn up for yellow pine.

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*Building Code recommended by the National Board of Fire Underwriters, page 282, 1915.

‡NOTE: These classes of timber are defined in the 1915 Yearbook of the American Society for Testing Materials, pages 431 and 432, and were adopted by this Society August, 1915, and by the American Railway Engineering Association March, 1916.

Where maximum strength requirements are desired the quality dense pine alone should be specified and used, but where the strength requirements are not of the highest character the grade sound pine will be found sufficient.

The size, character and distribution of knots may materially affect the strength of any good timber, as indicated in the appendix to the suggested Building Code of the National Board of Fire Underwriters.

"The weakening effect of knots also depends upon their position, as well as their soundness, tightness and the amount they distort the grain of the wood from a straight line. A comparatively small knot near the lower edge of a beam may be more harmful than a large knot located elsewhere. For example, a series of tests made upon loblolly yellow pine beams by the U. S. Forest Service, showed that the average strength of such beams with knots located in the bottom quarter of the middle half of the beams, was reduced 25% below that of similar beams with knots located in other portions. In such cases a knot near the neutral plane may act as a pin and serve to strengthen the beam against failure by horizontal shear.

"The number, character and location of defects in timber has much to do with its strength value. Checks and shakes in beams reduce the area which resist horizontal shear. Such defects are most harmful in the middle half of the height of the beam, as they are then comparatively near the neutral plane where their effect is greatest. The best place to judge of the effect of such defects is on the ends of the timber."

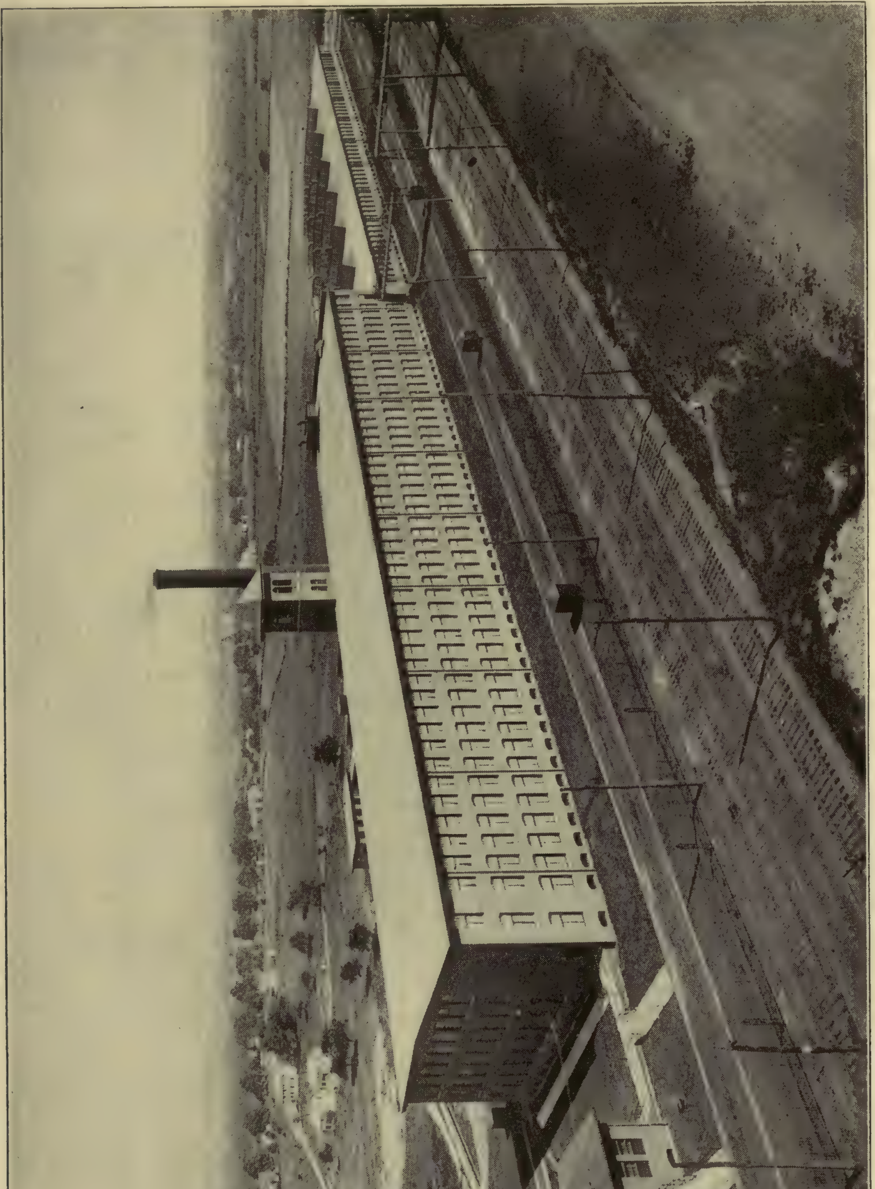
It should be noted that most timber specifications have explanatory clauses relating to the size of timbers as specified. The American Society for Testing Materials and the American Railway Engineering Association have adopted a clause which is used more or less universally, according to which rough sawed timbers should not be more than ¼ inch, nor dressed timbers more than ½ inch scant of nominal size; that is, a nominal 12″x12″ timber should not be less than 11¾″x11¾″ when sawed, or 11½″x11½″ when dressed.

The lasting power of timbers will be determined both by the kind and the quality of the wood used and by the conditions which obtain in the building in which it is employed. The timbers may have sapwood and heartwood in varying percentages. Sapwood is usually short-lived and where conditions are favorable to decay, will usually decay very rapidly. Heartwood, of practically all species, on the other hand, is comparatively long-lived. In buildings where the humidity is low such timbers usually last 25 and 30 years and longer when practically all-heart timbers are used. It is therefore of the utmost importance that consideration be given to the relation between sap percentage of timbers and the kind of use to which a mill construction building is to be put. Where low or average humidity is to be expected, timbers having 85% heart will usually give splendid service; and where the humidity is higher, the timbers should either be all heart or, in case sapwood is used, such timbers should be preserved either with a good quality of coal-tar creosote or, where this for various reasons may be objectionable, either with corrosive sublimate (usually known as the Kyanizing process) or with zinc chloride (usually known as the Burnettizing process). The presence of unlimited amounts of sapwood on timbers, which are to be used in buildings with high humidity, is strongly condemned. No amount of superficial painting with preservatives will be of any value.

Where untreated timbers are used, it will frequently be found advantageous to paint the ends and bearing surface of any timbers where they come in contact either with other timbers, with stone walls, metal or concrete surfaces. In such cases a high grade quality of distillate coal-tar creosote should be employed.

In the general selection of kinds of timber, yellow pine and Douglas fir will be usually specified for the stress bearing members such as girders and posts, this selection being based on the availability, suitability and cost of these woods. Consideration should also be given to white, Norway and Western pine, hemlock, tamarack, spruce and oak where they meet the requirements.

For flooring, roofing plank, trim and material where strength is not required, and low or medium humidity in the building does not demand special durability, a wider latitude in the selection is possible.



A Typical New England Cotton Mill of Heavy Timber Construction.
(Lockwood, Greene & Co., Engineers, Boston and Chicago.)

APPENDIX.

FORMULAS FOR DESIGN IN MILL CONSTRUCTION.

The design of the timber members of a mill construction type of building may be separated into the following divisions:

Floor and Roof Panels.
Girders and Beams.
Columns or Posts.

The various formulas used in the design of such members contain letters representing the quantities indicated below.

NOTATION FOR FORMULAS

$a = \frac{L}{d}$
b = Breadth of beam or girder in inches.
C = Strength of column in pounds per square inch of cross-section.
c = Allowable working compressive strength of timber in pounds per square inch with the grain.
D = Deflection in inches.
d = Depth of beam or girder, or least dimension of post in inches.
E = Modulus of elasticity of material in pounds per square inch.
f = Allowable unit bending stress in extreme fibers of section in pounds per square inch.
L = Unsupported length of post or column in inches.
l = Length of span of beam or girder in feet.
P = Load concentrated at any point on beam or girder in pounds.
s = Allowable unit shearing stress in direction of grain in pounds per square inch.
t = Thickness of underfloor, or roof plank in inches.
W = Total uniformly distributed load on beam or girder in pounds.
W_1 = Total uniformly distributed load on a section of floor or roof plank 1 foot wide and "x" long.
x = Length of span between centers of girders or beams in feet.

Floor and Roof Panels The minimum thickness of plank to be used in floors and roofs has been stated in the sections devoted to general construction and found in the earlier pages of this bulletin. The thickness needed to support a given uniformly distributed floor or roof load may be found from the following formula:

$$t^2 = \frac{3 W_1 x}{4 f} \quad \text{......................} (1)$$

To find the value of W_1, it will be necessary to know the kind of occupancy or the live load which is likely to be placed on the floor or roof, together with an allowance for the weight of the floor material itself. If sudden jars, vibration, or impact, is to be provided for, either a percentage may be added to the ordinary live loads, or the allowable working unit stresses may be decreased. The National Board of Fire Underwriters recommend that at least 25 percent be added to the stresses produced by live loads in structures carrying machinery, such as cranes, conveyors, printing presses, etc., to provide for effect of impact and vibrations.

The load which is likely to come upon a roof is made up of three parts; the dead load which consists of the weight of the roofing material and of roof structure; the snow load which may possibly come upon the roof, and a certain amount of load due to the wind. These must all be taken into account in making up the total. The element of wind load is not great on flat roofs, but the snow load may be quite an appreciable quantity. Table A gives average values for the snow load which may be present on buildings in different parts of the country.

The dead load may be found by estimating the quantity of material necessary to form the roof construction, and adding to it an amount to take care of the roof covering. Felt and gravel roofing of a 5-ply quality will weigh about 6 pounds per square foot of roof surface. Weights of timber and roofing materials will be found in Table B.

Live loads for various classes of occupancy may be estimated from Table C in case the local building ordinance does not specify a definite floor load for the class of building in question.

Table A.—Snow Loads in Different Localities.

Location.	Pounds per Sq. Ft. of Roof.
Southern and Pacific States	5
Central States	30
New England States	40
Northwestern States	45

Table B.—Average Weights of Timber and Roofing Materials.

TIMBER

(Not over 15% moisture)

Kind of Wood	Weight in Lbs. per Cu. Ft.
Cypress	29
Douglas Fir	32
Hemlock	26
Oak, Red	46
Oak, White	50
Pine, Cuban	40
Pine, Loblolly	40
Pine, Longleaf Yellow	38
Pine, Norway	31
Pine, Shortleaf Yellow	32
Pine, White	24
Spruce	25
Tamarack	35

Flooring	Weight in Lbs. per 1000 Ft. B. M.
Maple, Beech or Birch, 13/16 in.x1½ in. or 2¼ in.	2100
Spruce 13/16 in. thick	2000
White Pine and Hemlock " " "	1800
Yellow Pine " " "	2250
Douglas Fir " " "	2000

ROOFING MATERIAL

	Weight Lbs. per Sq. Ft. of Roof
Copper	1
Iron, Corrugated	1 to 4
Iron, Galvanized	1 " 3
Lead, Sheet	4 " 8
Shingles, Wood	2½
Slate	10
Tile, Fancy, laid in mortar	25 to 30
Tile, Plain	12
Tin, Painted	1
Zinc	1 to 2
Ready Roofing, 3-ply	1
Felt and Gravel Roofing, 4-ply	5½
Felt and Gravel Roofing, 5-ply	6

The following table, taken mainly from Report No. V., Boston Manufacturers Mutual Fire Insurance Co., gives the approximate weights of merchandise. In designing storehouse floors it is important to provide for the greatest load which is likely to be placed in the building.

Table C.—Weights of Merchandise.

MATERIAL	MEASUREMENTS		WEIGHTS		
	Floor Space Sq. Ft.	Cu. Ft.	Gross	Per Sq. Ft.	Per Cu. Ft.
Wool					
In bales, Australia “ East India “ New Zealand	8.6	19.4	350	40	18
“ South America	12.5	47.	1000	80	22
“ Oregon fleece	7.5	33.	550	73	17
“ California pulled	7.0	33.	480	70	15
“ Texas scoured	7.0	33.	480	70	15
In bags, Domestic	15.5	18.	250	16	14
“ scoured or noils	15.5	18.	100	6.4	5.5
Woolen Goods					
Case, Flannels	5.5	12.7	220	40	17
“ “ heavy	7.1	15.2	330	46	22
“ Dress Goods	5.5	22.0	460	84	21
“ Cassimeres	10.5	28.0	550	52	20
“ Underwear	7.3	21.0	350	48	16
“ Blankets	10.3	35.0	450	44	13
“ Horse Blankets	4.0	14.0	250	63	18
Cotton					
Bale, Ginned	9.32	46.6	550	60	12
“ Compressed	5.25	25.2	550	106	22
“ Planters Compress Co	1.80	5.4	250	139	47
“ American Cotton Co	2.60	7.8	270	104	35
“ Egyptian	4.7	20.0	820	170	41
“ Indian	4.7	20.0	860	176	43
Cotton Goods					
Bale Unbleached Jeans	4.0	12.5	300	72	24
Piece Duck	1.1	2.3	75	68	33
Bale Brown Sheetings	3.6	10.1	235	65	23
Case Bleached Sheetings	4.8	11.4	330	69	30
Case Quilts	7.2	19.0	295	41	16
Bale Print Cloth	4.0	9.3	175	44	19
Case Prints	4.5	13.4	420	93	31
Bale Tickings	3.3	8.8	325	99	37
Skeins Cotton Yarn	...	...	...	...	11
Carpet					
Roll of Carpet	4.1	10.9	129	31.5	11.8
Rug (with pole)	.44	4.	48	....	12.0
Silk					
Bale, Silk Cocoons	12.5	31.5	260	20.4	8.25
“ “ Frisons (average)	13.2	34.3	325	24.6	9.50
“ Dressed Silk	12.	24.	400	33.4	16.6
“ Raw Silk (average)	7.0	8.5	221	31.6	26.
“ Spun Silk	5.	7.5	235	47.0	31.4
Case Broad Silk Cloth	6.5	10.4	180	27.7	17.3
“ Ribbons	8.	16.	175	21.0	10.9
Jute, Etc.					
Bale, Jute	2.4	9.9	400	170	40
“ Jute Lashings	2.6	10.5	450	172	43
“ Manila	3.2	10.9	280	88	26
“ Hemp	8.0	30.0	650	81	20
“ Sisal	7.5	27.0	400	53	15
Burlaps, various packages	...	...	...	...	43
Jute Bagging	2.3	7.0	100	43	14

Table C.—(Continued).

MATERIAL	MEASUREMENTS		WEIGHTS		
	Floor Space Sq. Ft.	Cu. Ft.	Gross	Per Sq. Ft.	Per Cu. Ft.
Rags in Bales					
White Linen	8.5	39.5	910	107	23
“ Cotton	9.2	40.0	715	78	18
Brown “	7.6	30.0	440	59	15
Paper Shavings	7.5	34.	500	68	15
Sacking	16.0	65.0	450	28	7
Woolen	7.5	30.0	600	80	20
Jute Butts	2.8	11.0	400	143	36
Spruce Chips, wet, tightly packed	...	....	...	...	18
“ “ “ loosely “	...	....	...	...	14
“ “ dry	...	....	...	...	10
Paper					
16 x21, 30 lb. Ledger	2.4	5.3	210	130	60
16 x21, 24 lb. Calendered Book	2.4	4.4	250	105	57
16 x21, 29 lb. Super-cal. “	2.4	4.3	300	125	70
18½x29, 26 lb. News	3.7	5.9	270	73	46
32 x42, No. 38 Straw Board	9.3	3.9	130	14	33
24 x31, 52 lb. Manila Wrapping	5.2	10.8	530	102	49
Sheets in bundles, with wood frames	5.4	4.0	120	22	30
“ “ without “ “	6.3	4.2	140	22	33
Roll Newspaper	4.8	28.8	1200	250	41.0
Sulphite Pulp	...	....	...	...	17
Average Pile of Paper, in bundles	...	....	...	...	40
Tobacco					
Bale Sumatra Wrapper	6.1	6.0	150	24.5	24.7
Hogshead of Tobacco	8.-13.4	36.-80.4	1000-2200	..	28
Grain					
Wheat in bags	4.2	4.2	165	39	39
“ in bulk	...	....	...	...	44
“ “	...	....	...	...	39
“ “ mean	...	....	...	...	41
Barrels Flour on side	4.1	5.4	218	53	40
“ “ “ end	3.1	7.1	218	70	31
Corn in bags	3.6	3.6	112	31	31
Cornmeal in barrels	3.7	5.9	218	59	37
Oats in bags	3.3	3.6	96	29	27
Bale of Hay	5.0	20.0	284	57	14
Hay, Dederick Compressed	1.75	5.25	125	72	24
Straw, “ “	1.75	5.25	100	57	19
Tow, “ “	1.75	5.25	150	86	29
Excelsior, “ “	1.75	5.25	100	57	19
Dye Stuffs, etc.					
Hogsheads Bleaching Powder	11.8	39.2	1200	102	31
“ Soda Ash “	10.8	29.2	1800	167	62
Box Indigo	3.0	9.0	385	128	43
“ Cutch	4.0	3.3	150	38	45
“ Sumac	1.6	4.1	160	100	39
Caustic Soda in iron drum	4.3	6.8	600	140	88
Barrel Pearl Alum	3.0	10.5	350	117	33
Box Extract Logwood	1.06	.8	55	52	70
Barrel Lard Oil	4.3	12.3	422	98	34
Miscellaneous					
Rope	...	....	...	...	42
Box Tin	2.7	0.5	139	99	278
“ Glass	...	....	...	...	60
Crate Crockery	9.9	39.6	1600	162	40
Cask “	13.4	42.5	600	52	14

Table C.—(Continued).

MATERIAL	MEASUREMENTS Floor Space Sq. Ft.	Cu. Ft.	WEIGHTS Gross	Per Sq. Ft.	Per Cu. Ft.
Bale Leather	7.3	12.2	190	26	16
“ Goatskins	11.2	16.7	300	27	18
“ Raw Hides	6.0	30.0	400	67	13
“ “ “ Compressed	6.0	30.0	700	117	23
Bale Sole Leather	12.6	8.9	200	22	16
Pile “ “	...	....	....	...	17
Barrel Granulated Sugar	3.0	7.5	317	106	42
“ Brown “	3.0	7.5	340	113	45
Cheese	...	....	....	...	30
Pitch	...	....	....	...	72

ADDITIONAL WEIGHTS TAKEN FROM OTHER SOURCES ARE AS FOLLOWS:

Material	Weights per Cubic Foot of Space, Lbs.
Building Materials	
Cement, Portland	100
Lime and Plaster	53
Lumber (See Table B)	
Hardware, etc.	
Door Checks	45
Hinges	54
Locks, in cases packed	31
Sash Fasteners	48
Screws	101
Wire, Insulated Copper, in coils	63
Wire, Galvanized Iron, in coils	74
Wire, Magnet, on spools	75
Drugs, Paints, Oil, etc.	
Blue Vitriol, in barrels	45
Glycerine, in cases	52
Linseed Oil, in iron drums	45
Linseed Oil, in barrels	36
Rosin, in barrels	48
Shellac, Gum	38
Soda, Silicate, in barrels	53
Sulphuric Acid	60
White Lead Paste, in cans	174
White Lead, dry	86
Red Lead and Litharge, dry	132
Groceries, Wines, Liquors, etc.	
Beans, in bags	40
Canned Goods, in cases	58
Coffee, Roasted, in bags	33
Coffee, Green, in bags	39
Dates, in cases	55
Figs, in cases	74
Flour, in barrels	40
Molasses, in barrels	48
Rice, in bags	58
Sal Soda, in barrels	46
Salt, in bags	70
Soap Powder, in cases	38
Starch, in barrels	25
Sugar, in cases	51
Sugar, in barrels	43
Tea, in chests	25
Wines and Liquors, in barrels	38

If a stiff floor with a limited deflection is desired, the following formula may be used to find the amount of deflection due to a uniformly distributed load on a floor of a given thickness, span between beams or girders, and kind of timber:

$$D=\frac{22.5\,W_1\,x^3}{E\,t^3}\,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

The value of D is commonly limited to 1/30 of an inch per foot of length of span where a plastered ceiling is to be used, or 1/25 of an inch per foot when ceilings are left without plastering.

Girders and Beams The design of the girders used in a structure will depend upon the manner in which the loads are supported by these girders. In mill construction buildings where laminated or standard mill floors are used, the load is distributed uniformily along the length of the girders; but in cases where intermediate beams supporting the floor extend from girder to girder, the loads are concentrated at the ends of the girder and at one or more equally spaced intermediate points. These different methods of support cause different effects in bending and deflection. Formulas for bending, shear, and deflection will be given for three of the common cases.

LOAD UNIFORMLY DISTRIBUTED

Bending

$$d^2=\frac{9\,W\,l}{f\,b}\,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (3)$$

$$W=\frac{f\,b\,d^2.}{9\,l}\,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (4)$$

Shear

$$W=\frac{4}{3}\,b\,d\,s.\,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (5)$$

Deflection

$$D=\frac{270\,W\,l^3}{E\,b\,d^3}\,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (6)$$

ONE CONCENTRATED LOAD AT CENTER OF GIRDER

Bending

$$d^2=\frac{18\,P\,l.}{f\,b}\,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (7)$$

$$P=\frac{f\,b\,d^2}{18\,l}\,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (8)$$

Shear

$$P = \frac{4}{3} b\,d\,s \quad \ldots\ldots\ldots\ldots (9)$$

Deflection

$$D = \frac{432\,P\,l^3}{E\,b\,d^3} \quad \ldots\ldots\ldots\ldots (10)$$

TWO EQUAL CONCENTRATED LOADS AT THE THIRD POINTS OF GIRDER

Bending

$$d^2 = \frac{24\,P\,l}{f\,b} \quad \ldots\ldots\ldots\ldots (11)$$

$$P = \frac{f\,b\,d^2}{24\,l} \quad \ldots\ldots\ldots\ldots (12)$$

Shear

$$P = \frac{2}{3} b\,d\,s \quad \ldots\ldots\ldots\ldots (13)$$

Deflection

$$D = \frac{184.4\,P\,l^3}{E\,b\,d^3} \quad \ldots\ldots\ldots\ldots (14)$$

To find the value of W, multiply the length of the girder between supports in feet by the distance between centers of floor panels on each side of the girder in feet. Then multiply this result by the dead and live load to be carried in pounds per square foot of floor area. This same mode of procedure may be used to find the amount of load on each intermediate beam, using the length of the beam and the half panels of floor on each side of the beam.

The amount of the concentrated load P at a given point due to intermediate beams supported by a girder may be found by taking one-half of the total uniform load on each intermediate beam supported at that point.

Both the bending and shear formulas should be tested in determining the proper size of a girder or beam, or the amount of load which may be carried safely. Stiffness is determined by the formulas for deflection.

The bearing area needed at the ends of girders may be found by dividing the reaction at a given end by the working compressive strength across the grain for the timber used. If

Table D.—Maximum Spans for Timber Mill Floors.

Fiber stress 1,200, 1,300, 1,500, 1,600 and 1,800 pounds per square inch; modulus of elasticity, 1,620,000 pounds per square inch.

The sum of the live load and the weight of the floor was used in calculating the spans.

In the line marked deflection is given the span which has a deflection of one-thirtieth of an inch per foot of span.

(Actual thickness)
Made of matched and dressed plank.

Span in Feet

LIVE LOAD IN POUNDS PER SQUARE FOOT

Nominal Thickness	Actual Thickness	Fiber Stress Pounds Per Sq. In.	50#	100#	125#	150#	175#	200#	225#	250#	275#	300#	350#	400#
3″	2⅝″	1200	13′ 8″	10′ 1″	9′ 1″	8′ 4″	7′ 9″	7′ 3″	6′10″	6′ 6″	6′ 3″	6′ 0″	5′ 7″	5′ 2″
ʻʻ	ʻʻ	1300	14′ 3″	10′ 6″	9′ 6″	8′ 8″	8′ 1″	7′ 7″	7′ 2″	6′10″	6′ 6″	6′ 3″	5′ 9″	5′ 5″
ʻʻ	ʻʻ	1500	15′ 4″	11′ 3″	10′ 2″	9′ 4″	8′ 8″	8′ 2″	7′ 8″	7′ 4″	7′ 0″	6′ 8″	6′ 2″	5′10″
ʻʻ	ʻʻ	1600	15′10″	11′ 8″	10′ 6″	9′ 7″	8′11″	8′ 4″	7′11″	7′ 7″	7′ 2″	6′11″	6′ 5″	6′ 0″
ʻʻ	ʻʻ	1800	16′ 9″	12′ 4″	11′ 2″	10′ 3″	9′ 6″	8′11″	8′ 5″	8′ 0″	7′ 8″	7′ 4″	6′ 9″	6′ 4″
ʻʻ	ʻʻ	Deflection	9′ 0″	7′ 4″	6′11″	6′ 6″	6′ 2″	5′11″	5′ 8″	5′ 6″	5′ 4″	5′ 2″	4′11″	4′ 9″
4″	3⅝″	1200	18′ 5″	13′ 8″	12′ 4″	11′ 5″	10′ 7″	10′ 0″	9′ 5″	9′ 0″	8′ 7″	8′ 3″	7′ 7″	7′ 2″
ʻʻ	ʻʻ	1300	19′ 2″	14′ 3″	12′11″	11′10″	11′ 0″	10′ 4″	9′10″	9′ 4″	8′11″	8′ 7″	7′11″	7′ 5″
ʻʻ	ʻʻ	1500	20′ 7″	15′ 4″	13′10″	12′ 9″	11′10″	11′ 2″	10′ 6″	10′ 0″	9′ 7″	9′ 2″	8′ 6″	8′ 0″
ʻʻ	ʻʻ	1600	21′ 3″	15′10″	14′ 4″	13′ 2″	12′ 3″	11′ 6″	10′11″	10′ 4″	9′11″	9′ 6″	8′10″	8′ 3″
ʻʻ	ʻʻ	1800	22′ 7″	16′ 9″	15′ 2″	13′11″	13′ 0″	12′ 2″	11′ 7″	11′ 0″	10′ 6″	10′ 1″	9′ 4″	8′ 9″
ʻʻ	ʻʻ	Deflection	12′ 3″	10′ 1″	9′ 5″	8′11″	8′ 6″	8′ 2″	7′10″	7′ 7″	7′ 4″	7′ 2″	6′10″	6′ 6″
5″	4⅝″	1200	22′10″	17′ 8″	15′ 7″	14′ 5″	13′ 5″	12′ 7″	11′11″	11′ 4″	10′10″	10′ 5″	9′ 8″	9′ 1″
ʻʻ	ʻʻ	1300	23′10″	17′11″	16′ 3″	14′11″	13′11″	13′ 1″	12′ 5″	11′10″	11′ 4″	10′10″	10′ 1″	9′ 5″
ʻʻ	ʻʻ	1500	25′ 7″	19′ 3″	17′ 5″	16′ 1″	15′ 0″	14′ 1″	13′ 4″	12′ 8″	12′ 2″	11′ 8″	10′10″	10′ 2″
ʻʻ	ʻʻ	1600	26′ 5″	19′11″	18′ 0″	16′ 7″	15′ 6″	14′ 7″	13′ 9″	13′ 1″	12′ 6″	12′ 0″	11′ 2″	10′ 6″
ʻʻ	ʻʻ	1800	28′ 0″	21′ 1″	19′ 1″	17′ 7″	16′ 5″	15′ 5″	14′ 7″	13′11″	13′ 4″	12′ 9″	11′10″	11′ 1″
ʻʻ	ʻʻ	Deflection	15′ 4″	12′ 9″	11′11″	11′ 3″	10′ 9″	10′ 4″	10′ 0″	9′ 8″	9′ 4″	9′ 1″	8′ 8″	8′ 4″
6″*	5⅝″*	1200	......	20′ 8″	18′ 9″	17′ 4″	16′ 2″	15′ 3″	14′ 5″	13′ 9″	13′ 2″	12′ 8″	11′ 9″	11′ 0″
ʻʻ	ʻʻ	1300	......	21′ 6″	19′ 6″	18′ 0″	16′10″	15′10″	15′ 0″	14′ 3″	13′ 8″	13′ 1″	12′ 2″	11′ 5″
ʻʻ	ʻʻ	1500	......	23′ 1″	21′ 0″	19′ 4″	18′ 1″	17′ 0″	16′ 1″	15′ 4″	14′ 8″	14′ 1″	13′ 1″	12′ 3″
ʻʻ	ʻʻ	1600	......	23′10″	21′ 8″	20′ 0″	18′ 8″	17′ 7″	16′ 7″	15′10″	15′ 2″	14′ 7″	13′ 6″	12′ 8″
ʻʻ	ʻʻ	1800	......	25′ 3″	23′ 0″	21′ 2″	19′10″	18′ 8″	17′ 8″	16′10″	16′ 1″	15′ 5″	14′ 4″	13′ 6″
ʻʻ	ʻʻ	Deflection	......	15′ 4″	14′ 5″	13′ 8″	13′ 0″	12′ 6″	12′ 1″	11′ 8″	11′ 4″	11′ 0″	10′ 6″	10′ 1″

*Use for laminated floors when made of 2x6 and 4x6 pieces.

(Courtesy Southern Pine Association, New Orleans, La.)

Table E.—Maximum Spans for Timber Laminated Floors.

Fiber stress 1,200, 1,300, 1,500, 1,600 and 1,800 pounds per square inch; modulus of elasticity, 1,620,000 pounds per square inch.

The sum of the live load and the weight of the floor was used in calculating the spans.

In the line marked deflection is given the span which has a deflection of one-thirtieth of an inch per foot of span.

(Actual thickness)

Made of planks on edge, laid close.

Nominal Thickness	Actual Thickness	Fiber Stress Pounds Per Sq. In.	Span in Feet LIVE LOAD IN POUNDS PER SQUARE FOOT 100#	125#	150#	175#	200#	225#	250#	275#	300#	350#	400#
6″*	5½″*	1200	20′ 3″	18′ 4″	16′11″	15′10″	15′ 1″	14′ 1″	13′ 5″	12′10″	12′ 4″	11′ 6″	10′ 9″
"	"	1300	21′ 1″	19′ 1″	17′ 8″	16′ 5″	15′ 8″	14′ 8″	14′ 0″	13′ 4″	12′10″	11′11″	11′ 2″
"	"	1500	22′ 7″	20′ 9″	18′11″	17′ 8″	16′10″	15′ 9″	15′ 0″	14′ 4″	13′ 9″	12′10″	12′ 0″
"	"	1600	23′ 4″	21′ 3″	19′ 7″	18′ 3″	17′ 5″	16′ 4″	15′ 6″	14′10″	14′ 3″	13′ 3″	12′ 5″
"	"	1800	24′ 9″	22′ 6″	20′ 9″	19′ 4″	18′ 5″	17′ 3″	16′ 5″	15′ 9″	15′ 1″	14′ 0″	13′ 2″
"	"	Deflection	15′ 0″	14′ 1″	13′ 4″	12′ 9″	12′ 3″	11′ 9″	11′ 5″	11′ 1″	10′ 9″	10′ 3″	9′10″
8″	7½″	1200	26′10″	24′ 6″	22′ 8″	21′ 2″	20′ 0″	19′ 0″	18′ 1″	17′ 4″	16′ 7″	15′ 6″	14′ 7″
"	"	1300	27′11″	25′ 6″	23′ 7″	22′ 1″	20′10″	19′ 9″	18′10″	18′ 0″	17′ 4″	16′ 1″	15′ 2″
"	"	1500	30′ 0″	27′ 5″	25′ 4″	23′ 9″	22′ 4″	21′ 2″	20′ 3″	19′ 4″	18′ 7″	17′ 4″	16′ 3″
"	"	1600	31′ 0″	28′ 3″	26′ 2″	24′ 6″	23′ 1″	21′11″	20′10″	20′ 0″	19′ 2″	17′10″	16′ 9″
"	"	1800	32′10″	30′ 0″	27′ 9″	26′ 0″	24′ 6″	23′ 3″	22′ 2″	21′ 2″	20′ 4″	19′ 0″	17′10″
"	"	Deflection	20′ 1″	19′ 4″	17′11″	17′ 2″	16′ 6″	15′11″	15′ 5″	15′ 0″	14′ 7″	13′11″	13′ 4″
10″	9½″	1200									20′10″	19′ 5″	18′ 3″
"	"	1300									21′ 9″	20′ 3″	19′ 1″
"	"	1500									23′ 4″	21′ 9″	20′ 5″
"	"	1600									24′ 1″	22′ 5″	21′ 2″
"	"	1800									25′ 7″	23′10″	22′ 5″
"	"	Deflection									18′ 4″	17′ 6″	16′10″
12″	11½″	1200											22′ 0″
"	"	1300											22′11″
"	"	1500											24′ 7″
"	"	1600											25′ 4″
"	"	1800											26′11″
"	"	Deflection											20′ 3″

*Use for 2½x6, 3x6 and 6x6 pieces, for 2x6 and 4x6 use table for mill floors.

(Courtesy Southern Pine Association, New Orleans, La.)

the load on the girder is uniformly distributed, the reaction will be one-half of the load. If the result obtained by dividing the area thus found by the width of the girder is less than 5 inches, this distance should be taken as the minimum length of support. Table F gives values for compressive strength across the grain for timber.

The unit bending stress (f) may be taken from Table F, according to the kind of timber used. This table gives working unit stresses for structural timbers used in dry locations, and is compiled in the main from material furnished by the Forest Products Laboratory, Madison, Wis. Other values of unit stresses for use in the various formulas will be found in this same table. Where definite unit stresses are stated in the building code of a city, such values should be used in all calculations, but Table F may be used with safety when no scheduled values are demanded.

Table F.—Working Unit Stresses for Structural Timbers Used in Dry Locations.

	BENDING		COMPRESSION	
Species of Timber	Stress in Extreme Fiber	Horizontal Shear Stress	Parallel to Grain ''Short Columns''	Perpendicular to Grain
*Fir, Douglas	Lbs.Sq.In.	Lbs.Sq.In.	Lbs.Sq.In.	Lbs.Sq.In.
Dense Grade	1600	100	1200	350
Sound ''	1300	85	900	300
Hemlock, Eastern	1000	70	700	300
Hemlock, Western	1300	75	900	300
Oak	1400	125	900	400
Pine, Eastern White	900	80	700	250
Pine, Norway	1100	85	800	300
*Pine, Southern Yellow				
Dense Grade	1600	125	1200	350
Sound ''	1300	85	900	300
Spruce	900	70	600	200
Tamarack	1200	95	900	350

---

*NOTE: ''The safe working stresses given in this table are for timbers with defects limited according to the sections on defects in the rules of the Southern Pine Association for Select Structural Material. 'Dense' southern yellow pine and 'dense' Douglas fir should also conform to the other requirements of this rule. 'Sound' southern yellow pine and 'sound' Douglas fir require no additional qualifications, whereas the other species should, in addition to being graded for defects, have all pieces of exceptionally low density for the species excluded.''

For reference to ''dense'' and ''sound'' classes, see footnote page 48.

Table G.—Average Values of Modulus of Elasticity for Various Species of Timber.

Species of Timber	Modulus of Elasticity in Bending Lbs. per Sq. In.
*Fir, Douglas	
Dense Grade	1,600,000
Sound "	1,200,000
Hemlock, Western	1,400,000
Oak	1,300,000
Pine, Eastern White	1,300,000
Pine, Norway	1,400,000
*Pine, Southern Yellow	
Dense Grade	1,600,000
Sound "	1,200,000
Spruce	1,000,000
Tamarack	1,200,000

---

*See note at bottom of page 62.

Since the values of maximum spans in Tables D and E for a deflection of one-thirtieth inch per foot of length are based upon a value of 1,620,000 pounds per square inch for the modulus of elasticity, the lengths given in the "deflection" lines of these tables should be multiplied by a constant when timber having another value of the modulus of elasticity is used.

The following constants are based upon the value of moduli of elasticity given in Table G:

1,600,000—use tables as they stand.
1,400,000—multiply lengths in tables by .952
1,300,000—multiply lengths in tables by .929
1,200,000—multiply lengths in tables by .904
1,000,000—multiply lengths in tables by .852

Posts or Columns Text-books on strength of materials contain many different formulas for determining the load to be carried by a column, or the fibre stress resulting from the application of a definite load. Some of these formulas are based upon theory, others upon experiment and a few upon a combination of theory and experiment. While the loads and stresses obtained from such formulas do not vary greatly, it is considered that those of an empirical nature which correspond with the results of actual tests are more to be depended upon.

Table H.—Table of Safe Loads in Pounds Uniformly Distributed for Timber Beams.

Limited by Resistance to Horizontal Shear Along the Neutral Axis.

(Actual size)

Nominal Size	Actual Size	Horizontal Shearing Stress in Pounds per Square Inch				
		100#	125#	150#	175#	200#
6x10	5½x 9½	6966	8707	10449	12190	13932
8x10	7½x 9½	9500	11875	14250	16625	19000
10x10	9½x 9½	12032	15040	18048	21056	24064
6x12	5½x11½	8432	10540	12648	14756	16864
8x12	7½x11½	11500	14375	17250	20125	23000
10x12	9½x11½	14566	18207	21849	25490	29132
12x12	11½x11½	17632	22040	26448	30856	35264
6x14	5½x13½	9900	12375	14875	17325	19800
8x14	7½x13½	13500	16875	20250	23625	27000
10x14	9½x13½	17100	21375	25650	29925	34200
12x14	11½x13½	20700	25875	31050	36225	41400
14x14	13½x13½	24300	30375	36450	42525	48600
6x16	5½x15½	11366	14207	17049	19890	22732
8x16	7½x15½	15500	19375	23250	27125	31000
10x16	9½x15½	19634	24542	29451	34359	39268
12x16	11½x15½	23766	29707	35649	41590	47532
14x16	13½x15½	27900	34875	41850	48825	55800
16x16	15½x15½	32032	40040	48048	56056	64064
6x18	5½x17½	12834	16042	19251	22459	25668
8x18	7½x17½	17500	21875	26250	30625	35000
10x18	9½x17½	22166	27707	33249	38790	44332
12x18	11½x17½	26834	33542	40251	46959	53668
14x18	13½x17½	31500	39375	47250	55125	63000
16x18	15½x17½	36166	45207	54249	63290	72332
18x18	17½x17½	40832	51040	61248	71456	81664
20x20	19½x19½	50700	63375	76050	88725	101400

(Courtesy Southern Pine Association, New Orleans, La.)

NOTE—To use table for values of the horizontal shearing stress less than 100 pounds per square inch, multiply the safe load in the 100 column by the ratio of the unit stress used to 100. For example: For 85 pounds per square inch, use .85 of the load in the 100 column.

Two formulas which are used widely are given below. The first is the result of work done under the supervision of the Division of Forestry, U. S. Department of Agriculture, and is what is known as a "curved line formula." The second is a formula proposed by Mr. Benjamin E. Winslow, Mem. Am. Soc. C. E., and is of the "straight line" type. The Winslow formula is used to quite a considerable extent in practice and is incorporated in the Revised Building Ordinances of the City of Chicago.

U. S. Department of Agriculture, Division of Forestry Formula.

(Bulletin No. 12)

$$C=\frac{c(700+15a)}{(700+15a+a^2)}\dots\dots\dots\dots\dots\dots\dots(15)$$

Winslow Formula.

$$\left.\begin{array}{l}\text{Unit Stress on Column Cross-Sec-}\\ \text{tion in Pounds per Square Inch}\end{array}\right\}=c\left(1-\frac{L}{80d}\right)\dots\dots\dots\dots\dots\dots(16)$$

Loads on Columns The amount of load carried by a given column on a top floor is found by adding together the end reactions brought to the bolster or cap by the girders or beams which support the roof and rest on the cap. In the case of uniformly distributed loads, these reactions are each one-half of the load carried by that particular beam or girder. If the loading is not symmetrical on a beam or girder, the end reactions may be found by the principle of moments.

Columns on lower floors carry a central load from the line of columns above, in addition to the loads from beams and girders supported by the cap of the column in question.

While it is not probable that all of the floors of a building will be loaded to the capacity of the allowable live load at any time, recommendations in regard to the percentage of this maximum load to use vary in the building codes of different cities.

A common recommendation in the case of buildings exceeding five stories in height is to use the full live load on the roof and top floor; for each succeeding lower floor the live load is reduced by 5 per cent until 50 per cent of the live load is reached, then these reduced loads are used for all remaining floors.

Another recommendation of a more conservative nature is to allow no reduction of live load in buildings where the assumed floor load is more than 120 pounds per square foot and is likely to be permanent, as in warehouses, shops, etc.

Eccentric loads on columns should be avoided if possible. If present, they should be treated by the use of formulas governing such loading.

Table I.—Timber Columns.

(Actual size)

Safe Loads in Tons of 2,000 Pounds Based on the Formula of the U. S. Department of Agriculture, Division of Forestry.
Square end bearing and symmetrically loaded.

For formula see page 65.

Nominal Size, Inches	Actual Size, Inches	Area, Sq. In.	*L/d*	Length in Feet	Compression Parallel to the Grain Pounds per Sq. in. *1000
6x6	5½x 5½	30¼	17.5	8	11.50
‘‘	‘‘	‘‘	21.8	10	10.34
‘‘	‘‘	‘‘	26.2	12	9.29
‘‘	‘‘	‘‘	30.5	14	8.39
8x8	7½x 7½	56¼	12.8	8	23.76
‘‘	‘‘	‘‘	16.0	10	22.11
‘‘	‘‘	‘‘	19.2	12	20.48
‘‘	‘‘	‘‘	22.4	14	18.95
‘‘	‘‘	‘‘	25.6	16	17.52
‘‘	‘‘	‘‘	28.8	18	16.28
‘‘	‘‘	‘‘	32.0	20	15.06
10x10	9½x9½	90¼	10.1	8	40.29
‘‘	‘‘	‘‘	12.6	10	38.29
‘‘	‘‘	‘‘	15.2	12	36.21
‘‘	‘‘	‘‘	17.7	14	34.06
‘‘	‘‘	‘‘	20.2	16	32.08
‘‘	‘‘	‘‘	22.7	18	30.19
‘‘	‘‘	‘‘	25.3	20	28.32
12x12	11½x11½	132¼	8.3	8	61.02
‘‘	‘‘	‘‘	10.4	10	58.70
‘‘	‘‘	‘‘	12.5	12	56.21
‘‘	‘‘	‘‘	14.6	14	53.68
‘‘	‘‘	‘‘	16.7	16	51.11
‘‘	‘‘	‘‘	18.8	18	48.60
‘‘	‘‘	‘‘	20.9	20	46.20
14x14	13½x13½	182¼	7.1	8	85.75
‘‘	‘‘	‘‘	8.9	10	83.19
‘‘	‘‘	‘‘	10.7	12	80.46
‘‘	‘‘	‘‘	12.4	14	77.66
‘‘	‘‘	‘‘	14.2	16	74.63
‘‘	‘‘	‘‘	16.0	18	71.62
‘‘	‘‘	‘‘	17.8	20	68.61
16x16	15½x15½	240¼	6.2	8	114.57
‘‘	‘‘	‘‘	7.7	10	111.95
‘‘	‘‘	‘‘	9.3	12	108.95
‘‘	‘‘	‘‘	10.8	14	105.80
‘‘	‘‘	‘‘	12.4	16	102.34
‘‘	‘‘	‘‘	14.0	18	98.83
‘‘	‘‘	‘‘	15.5	20	95.49
18x18	17½x17½	306¼	5.5	8	147.45
‘‘	‘‘	‘‘	6.9	10	144.55
‘‘	‘‘	‘‘	8.2	12	141.48
‘‘	‘‘	‘‘	9.6	14	138.11
‘‘	‘‘	‘‘	11.0	16	134.29
‘‘	‘‘	‘‘	12.3	18	130.76
‘‘	‘‘	‘‘	13.7	20	126.78

---

*To use table for a unit stress other than 1,000 lbs. sq. in., multiply value in table by the ratio of that unit stress to 1,000. For instance: for 1,200 lbs. sq. in., multiply values in table by 1.2; for 900 lbs. sq. in., multiply by .9.

Table J.—Timber Columns.

(Actual size)

Safe Loads in Tons of 2,000 Pounds Based on the Winslow Formula.
(Chicago Building Ordinance.)

Square end bearing and symmetrically loaded.

For formula see page 65.

Nominal Size, Inches	Actual Size, Inches	Area, Sq. In.	L/d	Length in Feet	Compression Parallel to the Grain Pounds Per Sq. in. *1000
6x6	5½x 5½	30¼	17.5	8	11.82
"	"	"	21.8	10	11.01
"	"	"	26.2	12	10.18
"	"	"	30.5	14	9.35
8x8	7½x 7½	56¼	12.8	8	23.64
"	"	"	16.0	10	22.50
"	"	"	19.2	12	21.37
"	"	"	22.4	14	20.25
"	"	"	25.6	16	19.12
"	"	"	28.8	18	18.00
"	"	"	32.0	20	16.87
10x10	9½x 9½	90¼	10.1	8	39.42
"	"	"	12.6	10	38.03
"	"	"	15.2	12	36.55
"	"	"	17.7	14	35.20
"	"	"	20.2	16	33.84
"	"	"	22.7	18	32.32
"	"	"	25.3	20	30.85
12x12	11½x11½	132¼	8.3	8	59.51
"	"	"	10.4	10	57.53
"	"	"	12.5	12	55.78
"	"	"	14.6	14	54.10
"	"	"	16.7	16	52.24
"	"	"	18.8	18	50.58
"	"	"	20.9	20	48.93
14x14	13½x13½	182¼	7.1	8	82.93
"	"	"	8.9	10	81.10
"	"	"	10.7	12	79.27
"	"	"	12.4	14	76.96
"	"	"	14.2	16	74.97
"	"	"	16.0	18	72.90
"	"	"	17.8	20	71.07
16x16	15½x15½	240¼	6.2	8	110.84
"	"	"	7.7	10	109.00
"	"	"	9.3	12	106.15
"	"	"	10.8	14	103.86
"	"	"	12.4	16	101.44
"	"	"	14.0	18	99.05
"	"	"	15.5	20	96.86
18x18	17½x17½	306¼	5.5	8	142.55
"	"	"	6.9	10	139.90
"	"	"	8.2	12	137.54
"	"	"	9.6	14	134.75
"	"	"	11.0	16	132.11
"	"	"	12.3	18	129.74
"	"	"	13.7	20	127.09

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*To use table for a unit stress other than 1,000 lbs. sq. in., see directions with Table I.

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12

PURDUE UNIVERSITY

Agricultural Experiment Station

Circular No. 37

LaFayette, Ind., April, 1912

HOUSING FARM POULTRY

A. G. Philips

Division of Poultry, Department of Animal Husbandry

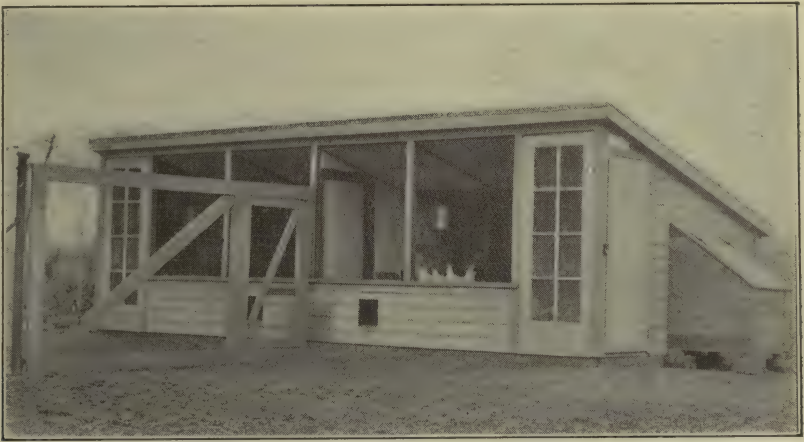
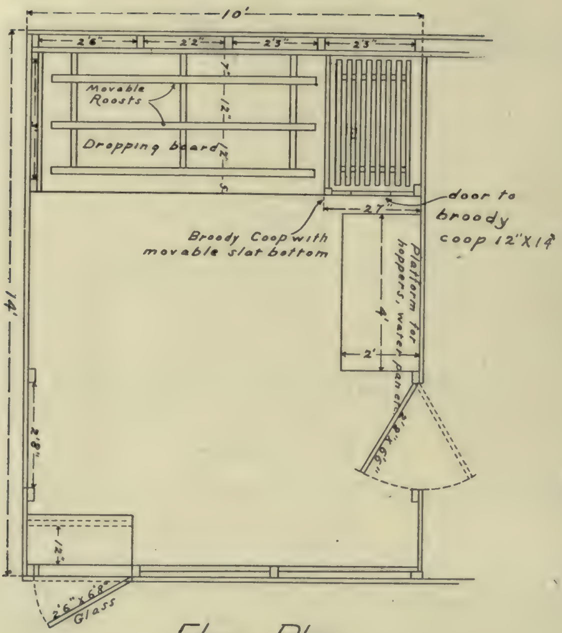
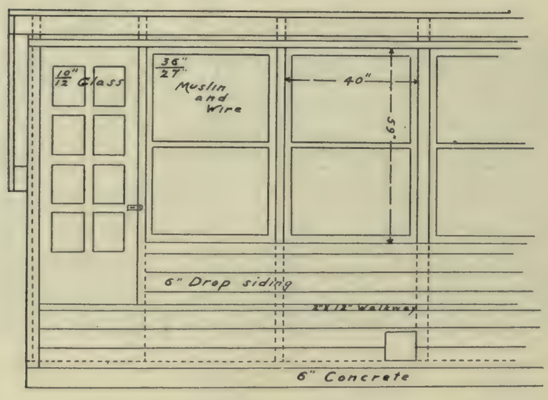


Fig. 1. Open front poultry house. The poultry house is the home of the hen

Good housing is one of the essentials for egg production and consequently should be given proper consideration. A hen that is comfortable and happy is more apt to be profitable than one that is uncomfortable.


10'
2'6"
2'2"
2'3"
2'3"
Movable Roosts
7"
12"
Dropping board
12"
5"
door to broody coop 12"X14"
27"
Broody Coop with movable slat bottom
Platform for hoppers, water pan etc.
4'
2'
14'
2'8"
2'8"X6'6"
12"
2'6"X6'8" Glass

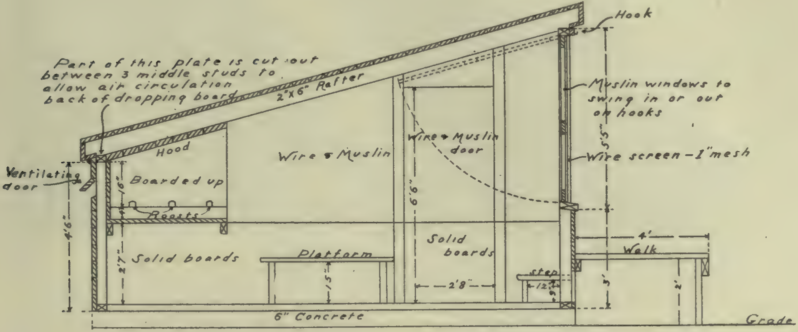
Floor Plan



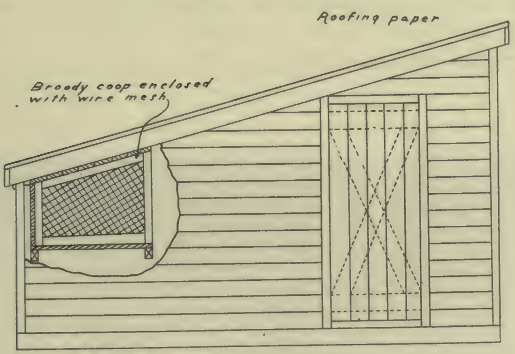
Front Elevation

Fig. 2. Open front poultry house

(Continuation of plans on page 2)



Cross Section



Side Elevation

Fig. 3. Open front poultry house

Working plan of a 10 x 14 pen for either a single or continuous house. Such a house has proven satisfactory at the Purdue Experiment Station. Illustration of this house is found on page 4.

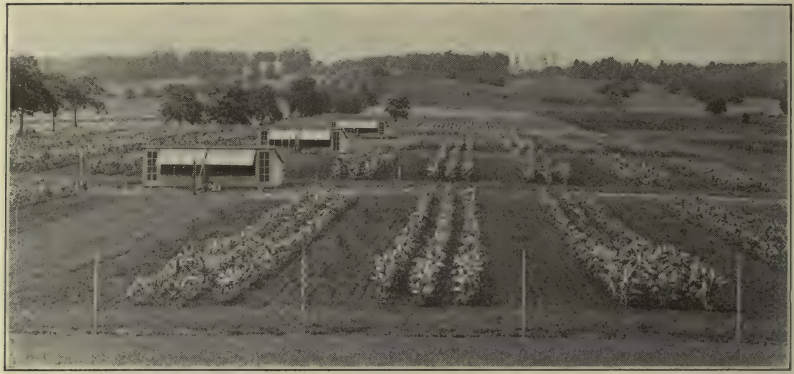


Fig. 4. The Purdue Experiment Station poultry farm

Note the growing crops on the land in the yards. One year old fruit trees are growing between the sets of corn rows. This system allows natural conditions for the fowls, and so egg production, fertility and hatchability are increased. By using orchards and cultivated fields no land need be especially set aside for poultry. Growing corn furnishes splendid shade.

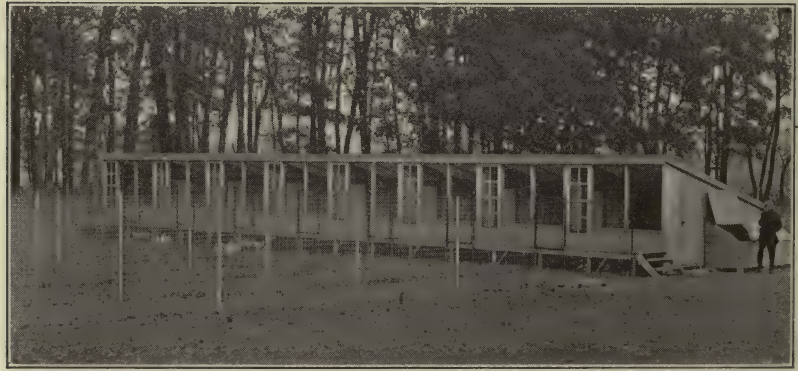


Fig. 5. Continuous house with small yards

An undesirable method of yarding, because the range for the fowls is restricted, soil contamination increased and labor more expensive.

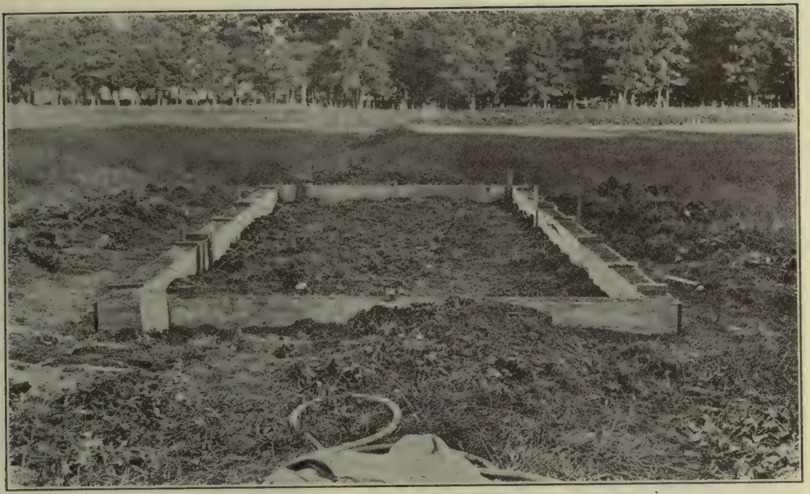


Fig. 6. Foundation of a poultry house

A good foundation is the first essential of a poultry house because it is rat, cold air, and water proof. For an ordinary house, a foundation 4 inches wide, 6 inches above and 12 inches to 16 inches below ground is satisfactory. The cut shows a board form filled with a 1 to 6 mixture of concrete. If the ground does not slope correctly or if the soil is very heavy, it sometimes is desirable to run a tile drain around the foundation to carry away any surplus water. Grade up around the foundation in order to drain the water away from the house.

When a foundation has been properly constructed, a good concrete floor should be put in. Fill the area inside of walls of foundation with gravel, cinders, etc., to within two inches of top, dampen and tamp it well. Put on top of this a 1 to 6 mixture of concrete. This floor will then have the contact with the soil broken, and hence always be dry. A concrete floor is cheaper to build than a board floor and far more sanitary. The front of the house should face the south and be on sloping, well drained land.

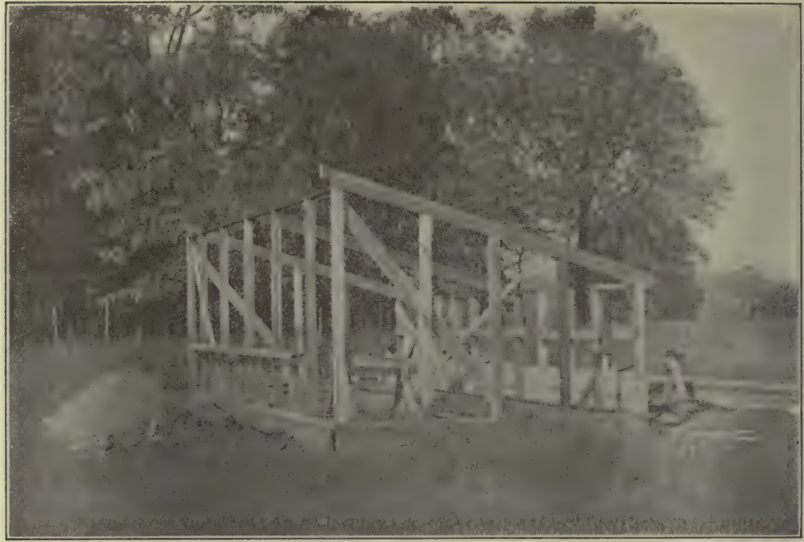


Fig. 7. Framework of poultry house showing construction

The materials used in a poultry house need not be expensive. Studding made of 2 x 4 yellow pine and rafters of 2 x 6 yellow pine will be of sufficient strength to hold any weight put upon them. As long as the walls, roof and floor of a house are tight, the principles of construction are correct. The materials used in making these tight, can be cheaply purchased. Sides made of drop siding will be tight, and a roof covered with 6 inch flooring or shiplap, on top of which is placed two-ply roofing paper, will be air and water tight and last for years. A shingle roof is not a satisfactory roof, for it is not air tight. A shed roof house is the most satisfactory where a house is to be only 14 to 15 feet deep. It is easier and cheaper to construct and allows plenty of sunshine to enter. Deep houses are warmer than shallow ones, and for that reason many practical poultrymen are building houses 20 to 24 feet deep.

A house 14 to 15 feet deep is the best, on the average farm, allowing 4 to 5 square feet of floor space per fowl. The front should be high enough to allow sunlight to reach the back of the house, seven or eight feet usually being high enough for such a depth. The rear need be no higher than necessary, four and one-half feet being generally found satisfactory.

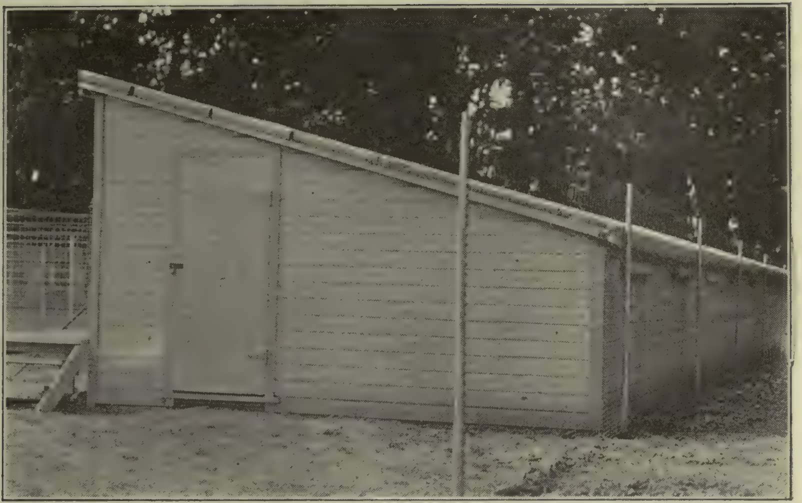


Fig. 8. Back of poultry house showing ventilator, wall construction and roofing materials

The ventilation of a poultry house is very important. A house with tight walls, roof and floor and an open front, will contain cold, dry, and pure air, three essentials for the health of the fowls in winter. With such a construction there will be no draughts, but plenty of fresh air. Cloth curtains on the front openings can be dropped on cold nights or during stormy weather, and a glass window will allow entrance of light at all times. Many cases of colds have been cured by removing the south side of the house and allowing sunshine and cold, pure air to enter. Hens must not freeze, neither do they need to be kept too warm.

In the summer time a ventilator in the back of the house is opened. Air enters this and goes up between the studding and rafters through the hood, above the heads of the fowls. This allows circulation of air, thereby allowing the warm air to escape, in the summer, without a draught on the chickens' heads. To allow for this air passage the back plate is cut out between three studding. See illustrations on pages 6 and 8.

It is not advisable to use ventilator shafts or other devices to insure ventilation. In fact many houses that have proved satisfactory in every way have no ventilating schemes whatever, nor any roosting hood.

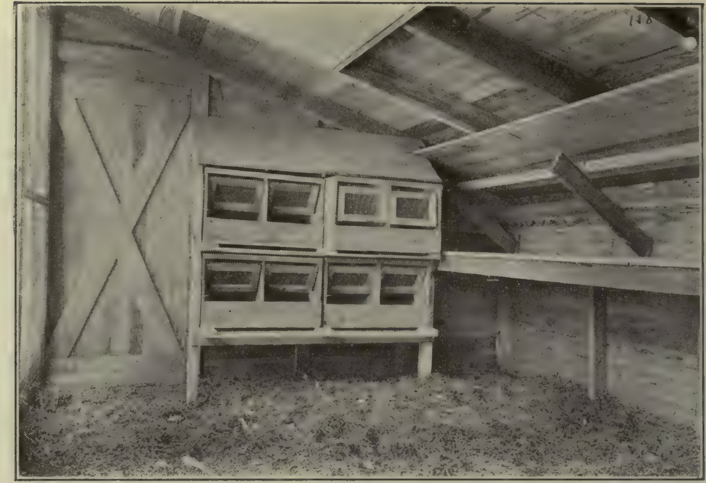


Fig. 9. Interior of poultry house showing raised roosts, and trap nests on wall

If nests are not placed under dropping boards, but are placed on the wall, they should be so constructed as to prevent hens roosting in them. Note hood in roosting quarter.

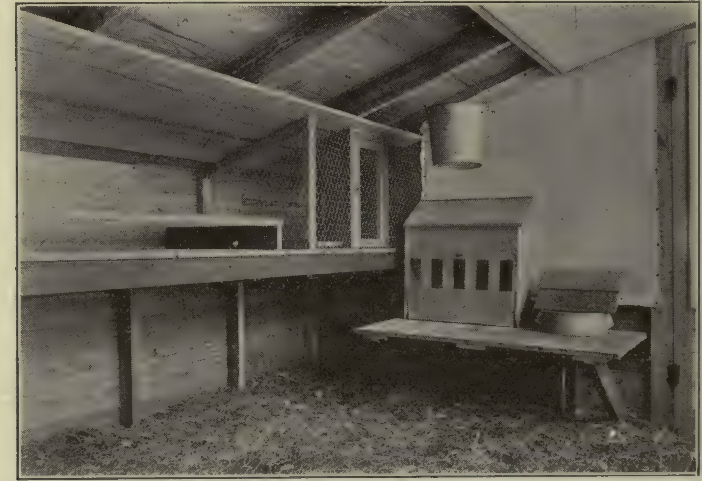


Fig. 10. Interior of poultry house showing platform on which are placed all feed and drinking vessels

This keeps everything up off the floor, insures cleanliness and prevents wasting.

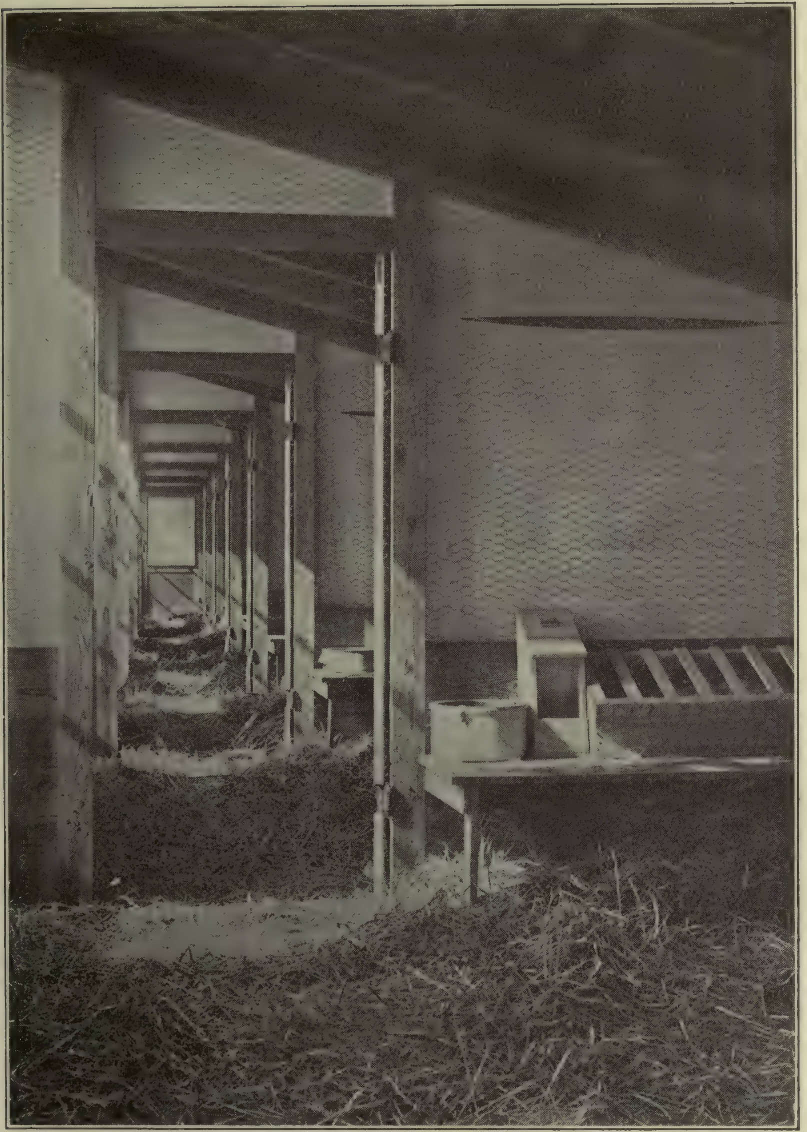


Fig. 11. Interior of continuous house

Note cloth and wire partitions used in winter to prevent circulation of air or draught. Also note platform supporting grit and feed hopper and water vessel. In this illustration the front curtains are closed. Note sunshine coming through windows at noon when curtains are closed.

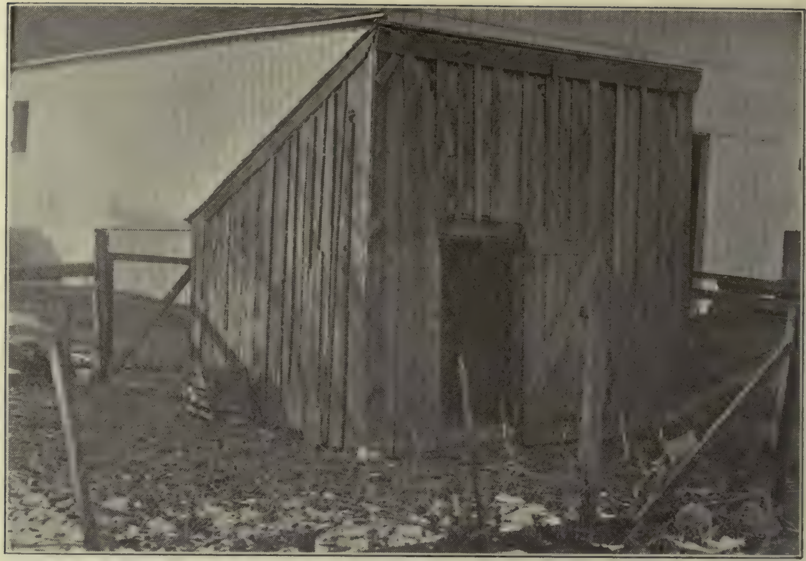


Fig. 12. A type of house too common on Indiana farms

This house is too high in front, full of cracks, very dark, has no foundation or floor and hence is damp and unhealthy. Even a window would have made an improvement in this house.

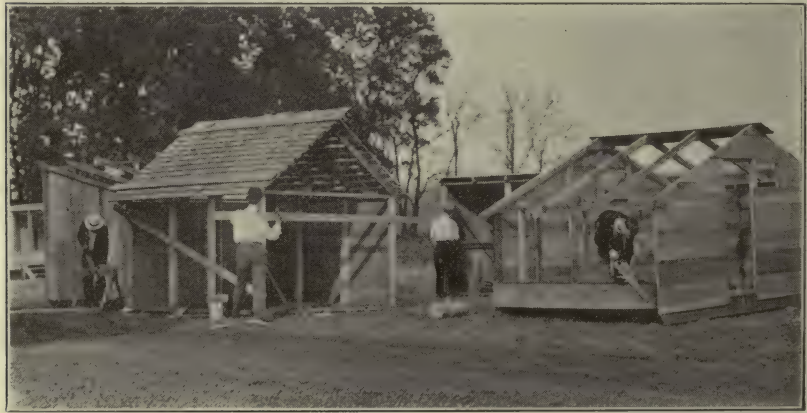


Fig. 13. Purdue students building different types of poultry houses

It is not necessary to be an expert carpenter to build a poultry house. These students are building four types of houses in order to find the most practical kind.

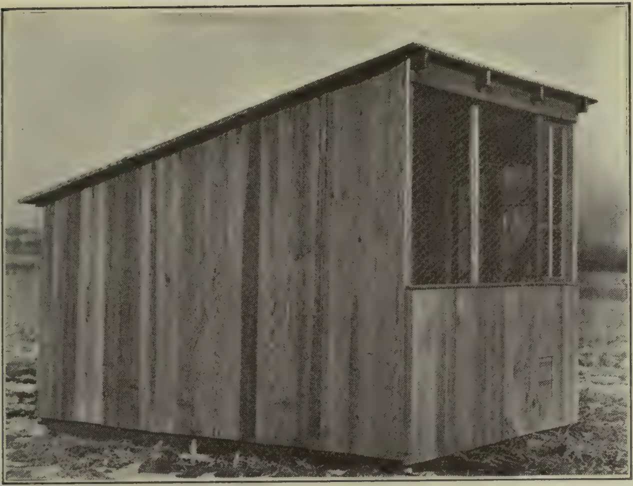


Fig. 14. Portable colony house. A house sided with flooring laid perpendicularly

This method of construction reduces the number of necessary studding.

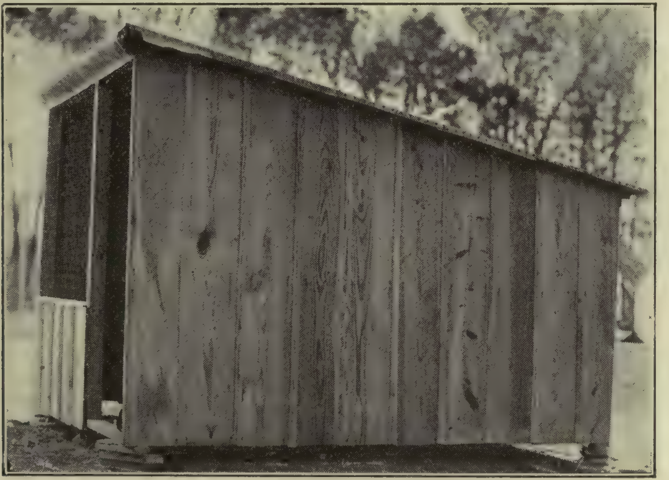


Fig. 15. Colony breeding house. A house sided with box boards—the cracks covered with battens

This is a common form of barn construction, but is not tight enough for a poultry house. The cracks will allow draughts to be formed.

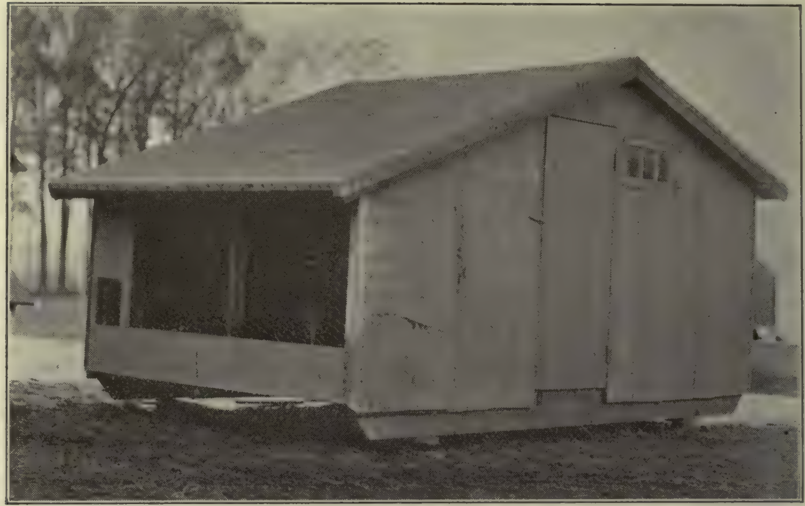


Fig. 16. Tolman colony house

This is a type of house rapidly coming into prominence in the middle west as a most satisfactory house. It has the advantage of reducing the air space, and also the lumber bill, besides always allowing plenty of fresh air. At Purdue this house is not light enough inside, and the hens all stay towards the front, not using the back half to any extent. In severe winter weather a curtain should be dropped over the opening, or the birds will freeze badly. In the summer some means of shade must be available for it becomes very hot and close inside. Placing this house on runners helps out the shade problem.

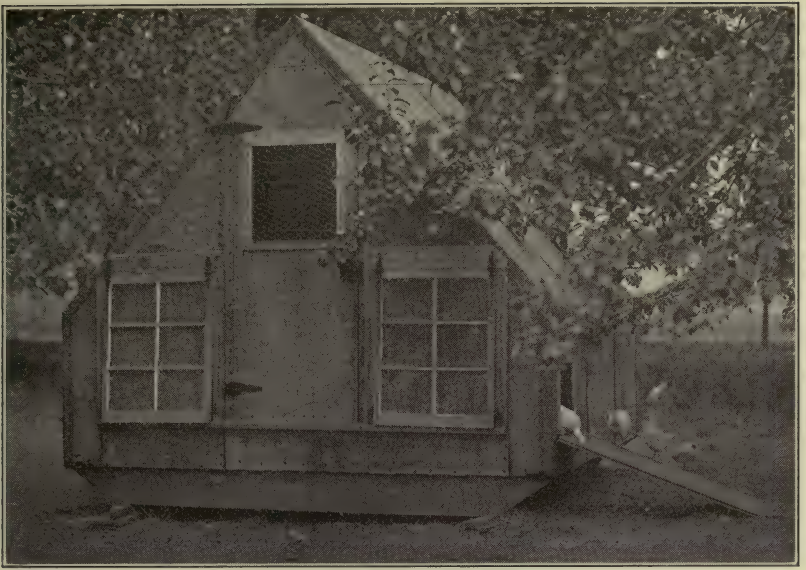
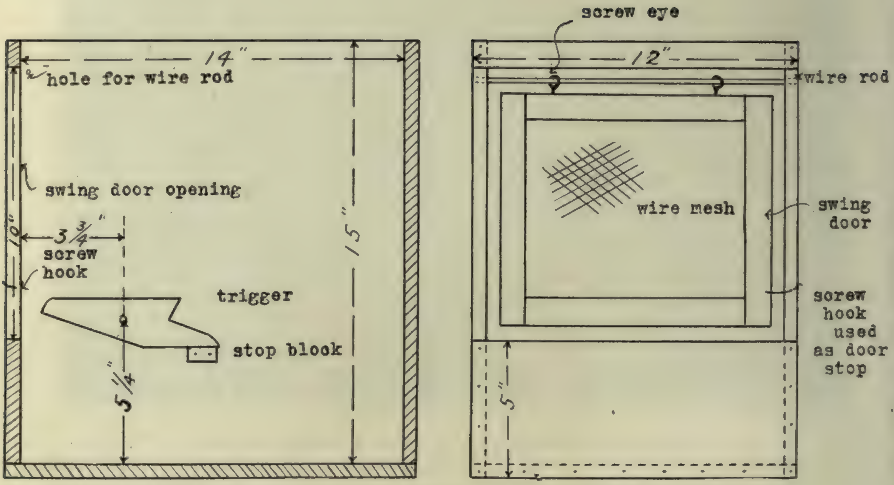


Fig. 17. A portable "A" shaped colony house

This is a type of house used at the Experiment Station as a brooder for 200 chicks in the spring, as a colony house during the summer, and a laying house during the fall and winter. It is placed on runners, and is easily moved. A colony brooder is the only type that can be used the year round, thus overcoming the common practice of having idle brooders eight months of the year.

This particular type of "A" shaped brooder is heated with gasoline, the hover and heating apparatus having been designed at Cornell University.

The Colony brooder is the cheapest brooder that can be built, saves much labor, and if heated by gasoline is the only brooder that supplies fresh air directly under the hover. The house can be moved from place to place and roosts put in when the hover is removed. This house is 8 x 8 feet square and 6½ feet high from floor to comb. It is not economical to use this size colony brooder where less than 150 chicks are brooded at once.



Side view

Front view

Outline of trigger

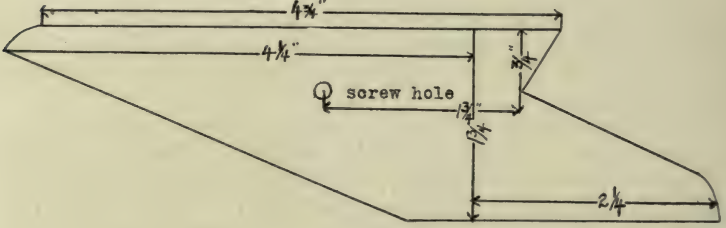
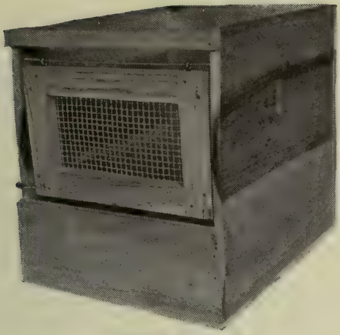
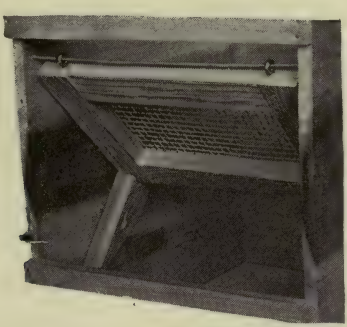


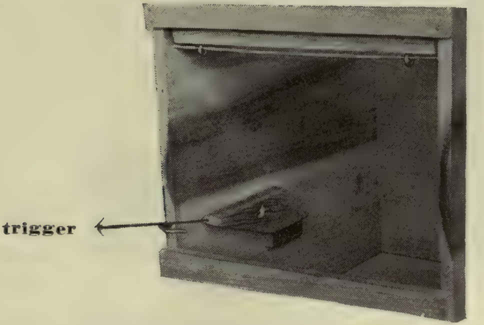
Fig. 18. Connecticut trap nest—working plan



Door closed



Door opened showing position of trigger
when trap nest is set



Door removed to show position of trigger
when door is closed

Fig. 19. Connecticut trap nest

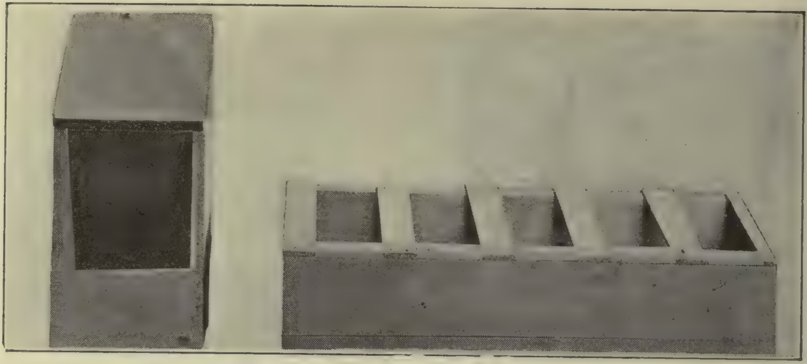


Fig. 20. Grit and feed hopper

To prevent waste of feed and reduce the labor of handling the dry mash, it is necessary to use hoppers. These two hoppers are cheap and easy of construction, and are being used satisfactorily on the Purdue farm. They are not rat proof. The grit hopper can be made longer and used as a dry mash hopper. The dry mash hopper should have a lid to use when it becomes necessary to shut off food supply.

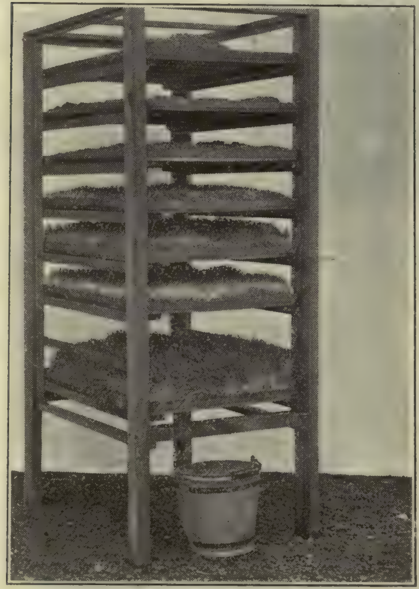


Fig. 21. Oats sprouter

Green food is essential as a part of the winter ration. When cabbage and beets are not available, sprouted oats can be easily fed. Soak the oats in a bucket for at least 24 hours and then place in a pile on top shelf of a sprouter. On the third day spread them out and let them grow to a height of not over two inches, then feed them. Keep the oats in a room of moderate temperature and dampen every day.

Acknowledgements for valuable assistance on this circular are due:

Mr. J. E. Dougherty, Poultry Department, Purdue, for the drawings.

Mr. J. C. Allen, Animal Husbandry Department, Purdue, for the photographic work.

Bulletin No. 132 June, 1912

FARM POULTRY HOUSES

Iowa Colony Houses in Use

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IOWA STATE COLLEGE OF AGRICULTURE AND THE MECHANIC ARTS

Agricultural Engineering and Animal Husbandry Sections

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FARM POULTRY HOUSES

BY J. B. DAVIDSON AND WM. A. LIPPINCOTT.

ESSENTIALS OF A SUCCESSFUL HOUSE.

Good growth of poultry and heavy egg production depend to a large extent upon the proper housing of the stock. This bulletin sets forth the essentials of a good house for Iowa in brief form and then offers working plans of three houses that embody these essentials.

LOCATION.

The first consideration in building a poultry house is its location. It is of greatest importance to select a site having well-drained soil as will be explained later. It is next important to have a convenient location. The poultry house may be nearer the residence than the live stock barns and as women have a large share in the management of the flock on the average farm, it should be so located. It is undesirable to build the poultry house near granaries, cribs, or barns which may furnish a harbor for rats and other vermin which prey on poultry. A sunny location well sheltered from the north winds is highly desirable whenever it is possible to obtain it without sacrificing good ground drainage.

DRYNESS.

The first essential of the house itself is that it be dry. There is no condition, unless it be actual starvation, that will be more surely and quickly fatal to fertility and egg production than dampness in the hen house. It is likely to cause an outbreak of disease as well.

To secure a dry hen house it is necessary first of all to select a dry location. A gentle slope to the south with good air drainage and a porous soil is the ideal building spot. The ground immediately surrounding will then drain quickly and the yards will be dry and warm. Where yards are damp, evaporation is constantly going on. Evaporation is a cooling process; so damp yards give the hens cold and dirty feet. Cold feet will lessen egg production; dirty feet will make dirty nests and eggs, and dirty eggs bring poor prices.

Often it is not possible to have an ideal location and then extra precaution must be taken. If the best site available is inclined to hold moisture, the moisture must be kept from getting into the house. Placing a 3 inch tile even with the bottom of the foundation and just at the outside as in plate VII, and giving it proper outlet will prevent the entrance of moisture to a large extent. The foundation should be high enough above grade to prevent the entrance of surface water.

Especial care needs to be taken in building the floor; its improper construction is one of the most common causes of dampness in hen houses. The board floor is generally dry because of the air space below it. Because of the high cost of lumber the tendency is toward the cement or dirt floor. In either case, if special precautions are not taken the moisture is likely to come up just as oil travels up a lamp wick.

To avoid this the capillary attraction must be broken. Whether a dirt or cement floor is used, remove enough dirt so that 6 to 8 inches of coarse material, preferably crushed rock, may be filled in. If a dirt floor is desired, spread some finer material as cinders over the rock and finally put six inches of dirt on top. Many people seem to prefer the dirt floor, but it is not nearly so sanitary as the cement floor. It requires much more labor to care for it properly. The cement floor is readily cleaned and will soon pay for its extra cost in the labor it saves. However, the cement will get as damp as the dirt unless the precaution noted above is taken to keep the moisture out. Over the crushed rock place a thickness of two ply roofing and carefully seal all seams and edges. Lay the grout above the roofing and finish with a half-inch finishing coat.

What has proven to be a very satisfactory floor was constructed in the poultry house shown in figure 6 by laying clay building blocks on their flat side on a bed of well settled gravel and plastering the whole with cement plaster. This floor is cheap and has proved to be warm and dry in the particular instance in which it was tried.

Single wall houses are cheaper than double wall houses and this, together with the fact that they are generally drier, commends their use. Whether or not the double wall can be made entirely satisfactory the authors cannot say at this time, but the single wall has proved to be eminently successful.

VENTILATION.

Good ventilation without drafts is the second essential of a good poultry house. Without it, it is difficult to have a house that is either dry or sanitary.

The hen, compared with other animals, has a high temperature which will average about 106° F. This means a rapid combustion within the body and for rapid combustion much fresh air is necessary. It has been estimated (King, Physics of Agriculture), that a horse weighing 1,000 lbs. breathes little less than 3,500 cu. ft. of air in every 24 hours. A 1,000 pound cow requires less than 3,000 cu. ft. Two hundred 5 pound hens, while weighing the same as the horse or the cow, will breathe over 8,000 cu. ft. of air in the same length of time.

Instead of ridding the body of the excreta of the kidneys in liquid form as other farm animals do, the hen gives them off as a white paste that is passed with the feces. All the water that in other animals passes off in the urine must be largely gotten rid of by the respiratory system. In order to do this work, nature has given the hen not only a good pair of lungs, but also a system of air sacks extending to all parts of the body which are even connected with the cavities in the bones. Unless there is fresh air to reach all parts of the body, the hen will not do well. Unless there is a good ventilation to carry off the moisture of respiration, the house is bound to be damp.

The fact that the birds are kept in quite large flocks is an added reason for thorough ventilation. King points out in his Physics of Agriculture that the poisonous principle given off by one individual is much more poisonous to another individual who is compelled to breathe it than it is to the individual giving it off. It is no uncommon thing to see a hundred hens on an Iowa farm crowded into a little house with practically no ventilation. No matter how well such hens are fed there will be a lack of thrift if each hen is compelled to breathe the poisonous gases given off by the rest of the flock.

In order to secure good ventilation and at the same time have absolute freedom from draughts, a house termed the ''open front'' or ''curtain front'' house is built. See figures 3 and 6. This house is made absolutely tight on three sides by the use of matched boards and prepared roofing. The fourth side is equipped with cloth covered frames as in figure 6. These are opened in calm weather even though it is cold. When it is stormy, they are lowered to keep out the rain and snow. While a hen can roost in a tree in a high wind without catching cold, the moment she is placed in a direct draught inside of a house, she becomes sniffly. It takes only a short time for a cold to progress into a well-developed case of roup. Once established, roup is likely to go through the whole flock. It is well to place cloth frames rather high so as to avoid having the wind blow directly on the fowls when scratching on the floor. A good wind break on the north and west sides often makes it possible to leave the curtains open on quite stormy days.

SUNLIGHT.

A third essential of a successful chicken house is plenty of sunshine. It is in the spring that hens lay the most eggs. If we are to secure winter eggs we must reproduce spring conditions as far as possible. So far as the hen house is concerned, nothing comes nearer to it than flooding the house with light. To do this the front of the house is so constructed that it may be thrown completely open on sunny days. See figure 3. This is an advantage, not only because it brings comfort to the house, but also because sunlight is one of the best germicides and disinfectants. It helps to prevent disease. It has been found that hens, in common with plants, prefer the morning to the afternoon sun if they cannot have both. For this reason the window which must be the source of light on windy days or stormy days is placed at the east end of the front side of the pens. It should be placed as high as possible so that the sun will go clear to the back of the pen. Below it is placed a cellar sash as in plate VI which admits the sun to a covered dust bath where the hens may wallow all winter as they do in early spring. This dust bath will take care of the louse problem.

DISINFECTION.

Because of the small size and corresponding small value of the individual hen, not much time can be spent doctoring her if she is taken sick. Yet many of the poultry diseases are highly contagious. If they once gain entrance to the flock, every bird is likely to be affected. The only satisfactory way to deal with poultry disease, therefore, is to prevent it and this is done by cleaning and disinfecting.

A fourth essential of a good poultry house, then, is ease of disinfection. This means that all nests, perches, dropping boards and other appliances must be removable, so that they may be easily cleaned and sprayed. The construction should be as light as possible so that there will be a minimum of cracks and crevices. It is in the cracks that the mites breed. They attack the hens when on the nest or the perch and hide between the boards or in any crack they can find during the day. Such cracks as are unavoidable must be easily gotten at. Build perches, nests, and similar fixtures so they are removable. Matched boards used for siding should be laid on perpendicularly where practicable, instead of horizontally as is usually done. When the house is sprayed, this allows the disinfectant to run down the cracks and penetrate more deeply and thoroughly.

PORTABILITY.

The hen house on the farm is generally, as it should be, a permanent structure. For raising stock, however, it is highly advantageous to have a house that may be moved from place to place. This is particularly true where the incubator is used and the chicks reared artificially. Several of the common chicken diseases live in the ground from year to year. If the chickens are raised on new ground each year, the danger of disease creeping in one season, contaminating the ground and attacking the chicks the next season, is avoided.

Range raised stock, other things being equal, is more vigorous and sturdy than stock raised in confinement. With a portable house, the chicks may be given the run of the corn field or the orchard and two crops raised on the same ground.

The portable house differs from the ordinary hen house only in two particulars. It is usually smaller. It is placed on sills which act as runners. If it is to be hauled down the orchard rows without interfering with the tree limbs, it should have a combination or gable roof. A team can haul it to any part of the farm where the ground is reasonably level.

ECONOMY.

An essential of any building used for making money is economy. The hen house should be no larger than is necessary and of such a shape that there will be the most floor space for a given length of wall. There should be 5 square feet of floor space allowed for each bird if good results are looked for.

If we build poultry houses on the basis of allowing a cubic foot of air space per pound live weight as we do barns, a 5 pound hen with 5 square feet of floor space allotted to her would have a house but one foot high. In order to have head room for working, however, it is necessary to make the house a great deal higher. Just how high depends on the preference of the owner.

For practical purposes, the square pen gives the most floor space for a given length of foundation wall. The round pen gives the most floor space but increased cost of construction and the irregular yards resulting overbalance this advantage.

PLANS.

Any poultry house which is built along the lines suggested above ought to be a good house. Detail plans, however, are furnished in the following pages for three different styles of construction which have been tried at the Iowa Agricultural Experiment station and found to be eminently successful. The authors do not wish to claim originality for the designs submitted, as ideas have been gathered from many sources.*

These designs offer a considerable range of choice. It is not essential that they be followed absolutely, yet an attempt has been made to furnish definite and detailed plans and instructions to those who desire such explicit information. In addition to the regular design, some modifications of shape and materials are suggested.

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*It is desired to make particular mention of the assistance secured from the work of Professor H. C. Pierce, formerly in charge of Poultry Husbandry at Iowa Agricultural Experiment Station.

The three poultry house plans furnished in this bulletin have been designated as follows:

A-Shaped Portable Poultry House,
Iowa Colony House,
Farm Poultry House.

A-SHAPED PORTABLE COLONY HOUSE

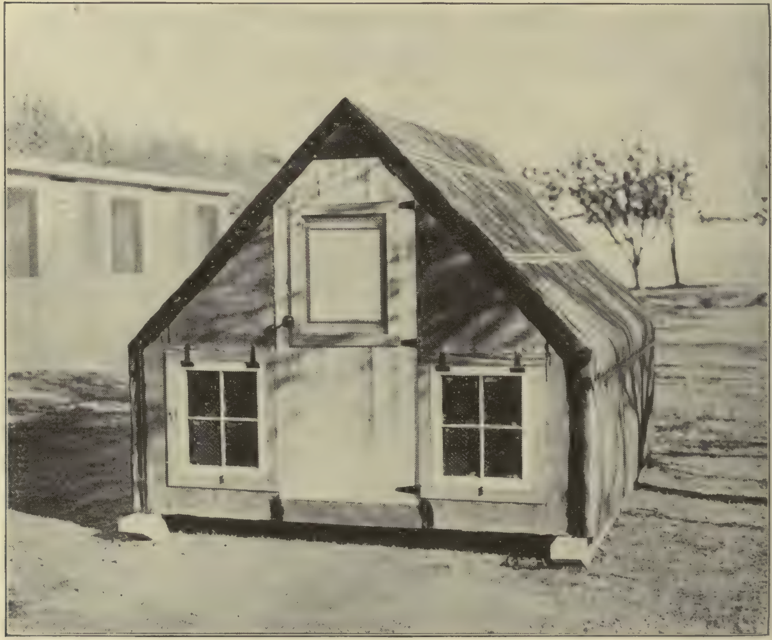
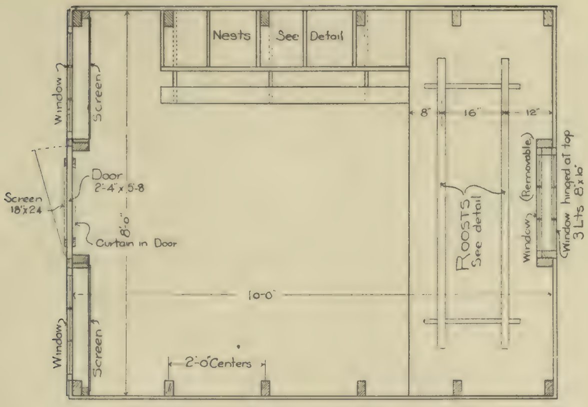
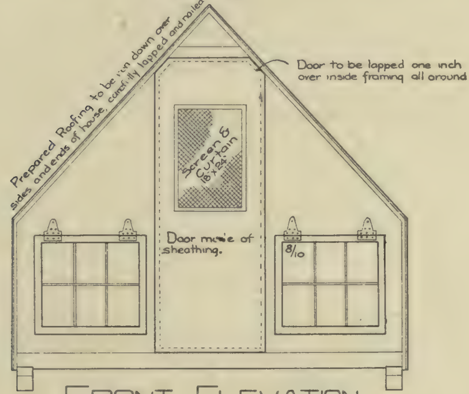


Fig. 1—Front View of A-Shaped Portable Poultry House.
It is more convenient to lay the prepared roofing over the ridge instead of lengthwise as shown.

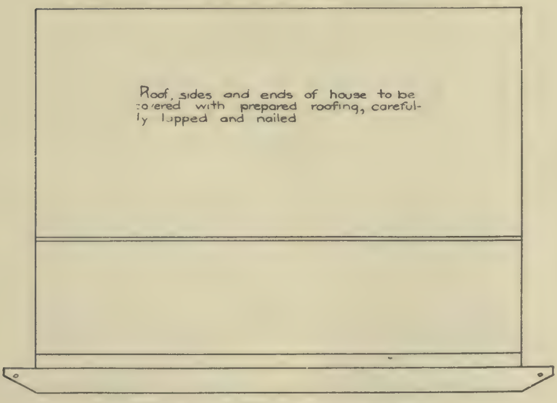
This A-shaped movable colony home is cheap and light and has been thoroughly tried out and found to be very satisfactory for raising chicks in flocks of 200 to 300. It will winter from 15 to 20 hens. The house is 8x10 feet and because of its lightness and substantial construction it can be readily moved from place to place on the skids which furnish the foundation for the house. It is warm and the fowls are well protected from drafts. It is convenient and the minimum of work will be required to care for the flocks.



PLAN


Prepared Roofing to be run down over sides and ends of house, carefully lapped and nailed
Door to be lapped one inch over inside framing all around
Screen & Curtain 18"x24"
Door made of sheathing.
8/10

FRONT ELEVATION


Roof, sides and ends of house to be covered with prepared roofing, carefully lapped and nailed

SIDE ELEVATION

Plate I—A-Shaped Portable Poultry House.

CONSTRUCTION.

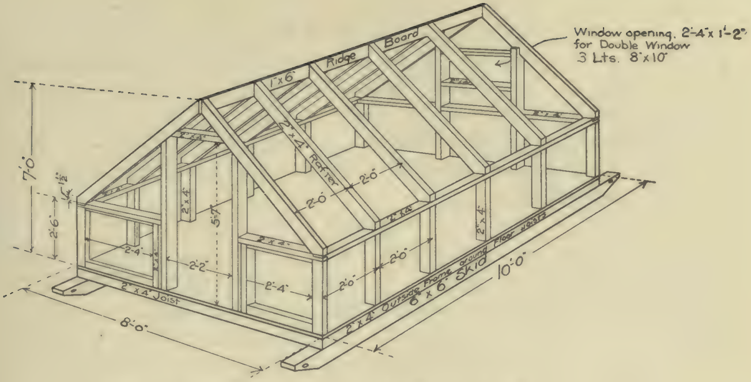
The skids which form the foundation of the house are 6x6 inch pieces, 11 feet long; 4x6 stock might be used, in which case the pieces should be set on edge. Yellow pine or any good quality of lumber will be satisfactory. The joists are 2x4 inch scantlings laid across the skids, two feet apart. To stiffen the foundation, a 2x4 piece is spiked across the ends of the joists but this piece may be omitted. The floor joists as well as the remainder of the frame should be made of a good quality of framing lumber, yellow or white pine being preferred. The frame shown in the accompanying drawings is made entirely of 2x4 stock with the exception of the ridge pole. Rafters 1x3 inches have been used with good success.

The floor is made of plain, tongued and grooved 6-inch flooring and laid entirely over the joists before the studding is put in place. The frame is nailed securely to the floor and sheathed with a good grade of shiplap planed on one side and nailed in place with the smooth side in. With the style of framing used, it is quite necessary to nail this sheeting on horizontally. After this sheeting is securely nailed in place, the whole structure outside of the door opening is covered with a good grade of prepared roofing. The roofing is more easily applied if the strips are run over the ridge of the building rather than horizontally as is usually customary. This method also adds some to its appearance. The laps should be well cemented and nailed with washered nails or through a batten.

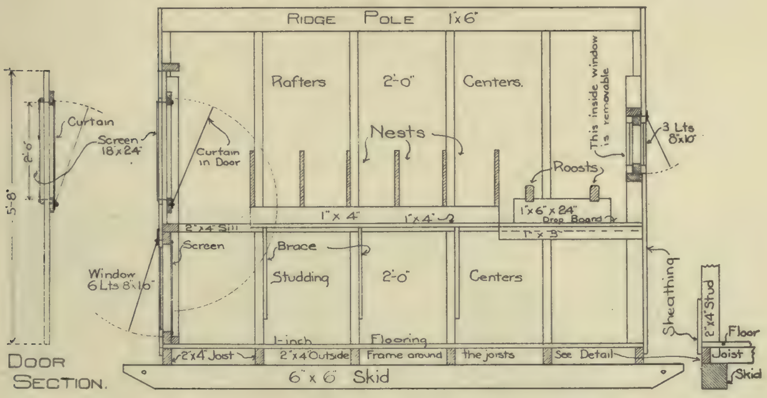
The window opening for the rear window is sawed out and the window is set in the frame against a ½-inch strip used as a stop. The front windows as shown in figure one and plates one and three are larger than the opening and rest against the frame all the way around, obviating the use of a stop inside of the frame. In some styles of construction the window frames are omitted, but in the judgment of the authors they are desirable and worth the extra cost. To permit the hinges to be placed on the windows readily, a casing is put around them of such a thickness as to build the sheathing up to the thickness of the windows.

The front windows should be made of six 8x10 inch light sash, although a smaller sash is shown in the illustrations. The rear window is made double with two sashes of three 9x12 inch lights in the same opening. As the birds roost near this window, it is desirable that all possible drafts should be guarded against. In the summer time, the inside window may be removed and stored inside of cleats nailed to the rafters.

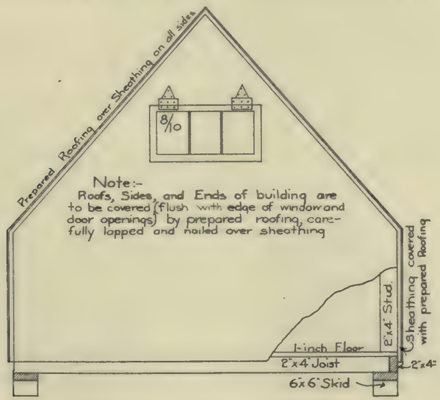
The door is made of matched flooring and made substantial with three battens. The door is 1 inch larger than the opening all around as this not only gives a tighter fit but requires less labor in construction.



PERSPECTIVE OF FRAMING



LONGITUDINAL SECTION


Prepared Roofing over Sheathing on all sides
8/10
Note:- Roofs, Sides, and Ends of building are to be covered (flush with edge of window and door openings) by prepared roofing, carefully lapped and nailed over sheathing
2" x 4" Stud.
Sheathing covered with prepared Roofing
1-inch Floor
2" x 4" Joist
2" x 4"
6" x 6" Skid

REAR ELEVATION

Plate II—A-Shaped Portable Poultry House.

The door has an opening 18x24 inches, covered outside with ½-inch mesh galvanized wire netting and fitted on the inside with a frame covered with light muslin. This frame is hinged at the bottom, permitting it to be swung downward on the inside during the mild weather or to admit sunlight.

Figure 1 shows the general outside appearance of the building after construction.

NESTS.

There are 5 nests altogether, placed on the left side of the building although it would be possible to place nests on the opposite side if desired. The nests are removable for cleaning and rest on brackets nailed to the studding. The partitions, bottom, and front of the nests are nailed together. The platform in the front of the nests is 4 inches wide and is set out 2 inches in front of the nests in order to prevent the latter from becoming fouled with droppings. Seven-eights inch material is used throughout in the construction of the nests.

ROOSTS AND DROPPING BOARD.

The dropping board is made to slide into place at the rear of the building over strips nailed to the plates at either side.

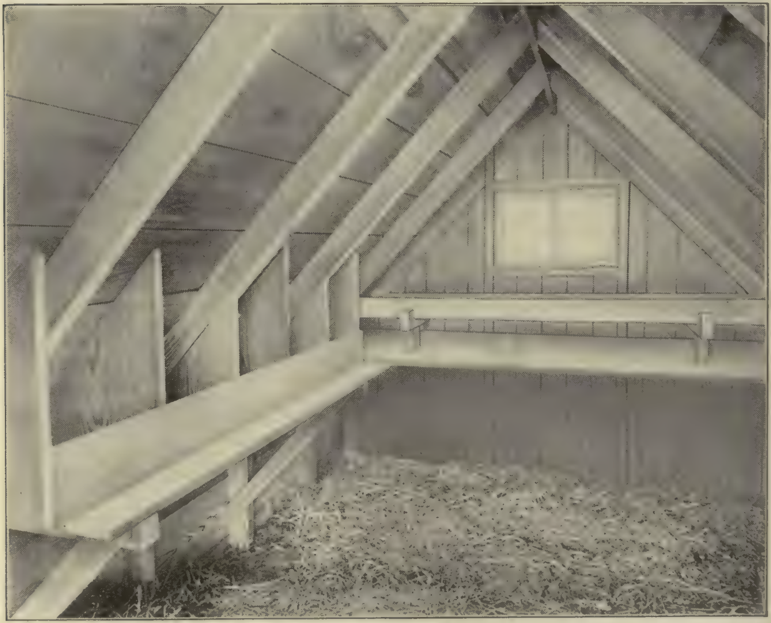
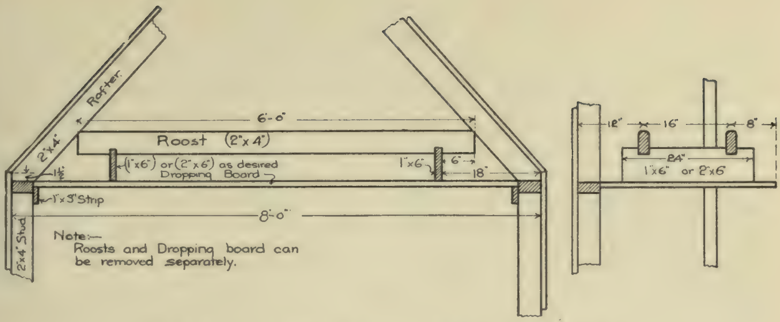
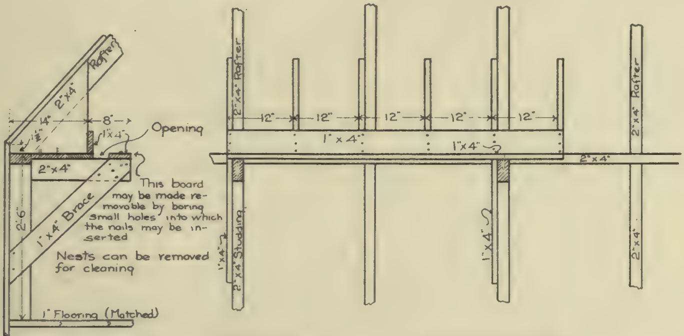


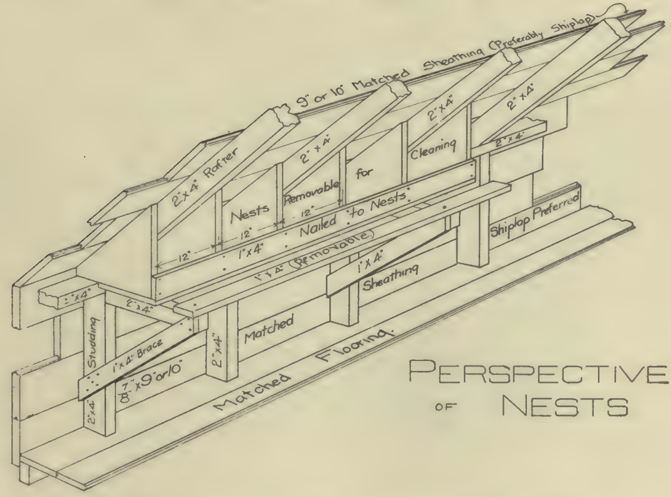
Fig. 2—Interior View of House Shown in Figure 1 and Plates I, II, and III, Showing the Roosts and Nests.



ROOSTS AND DROPPING BOARD



DETAIL OF NESTS



PERSPECTIVE OF NESTS

Plate III—Details of A-Shaped Portable Poultry House.

The roosts or perches, which are 2 in number, each 6 feet long, rest on brackets made up from any convenient material. The roosts are loose and are notched and set in notches in the brackets or supports.

In moving the building from place to place, some care should be used in drawing the skids and not subjecting the building to any undue racking. One good plan is to hitch one horse to each skid. If this is not done, a spreader should be placed between the chains to each skid.

BILL OF MATERIALS FOR A-SHAPED MOVABLE HOUSE.

Skids: 2 pieces 6"x6" or 4"x6"x12 feet dimension.
Joists: 6 pieces 2"x4"x8' yellow pine.
  2 pieces 2"x4"x10' yellow pine.
Floor: 17 pieces 1"x6"x10' matched flooring.
Studding and frames: 8 pieces 2"x4"x2'6" studs.
  2 pieces 2"x4"x6'0" studs.
Plates: 8 pieces 2"x4"x2'6" yellow pine dimension.
  2 pieces 2"x4"x10'.
Rafters: 12 pieces 2"x4"x6' yellow pine dimension.
Ridge pole: 1 piece 1"x6"x10' white pine.
Sheathing for ends and door: 18 pieces 1"x6"x10' white pine flooring.
  3 pieces 1"x6"x16' white pine flooring.
Sheathing for sides and roof: 23 pieces ⅞"x10"x10' shiplap.
Nests: 2 pieces 2"x4"x2' brackets.
  2 pieces 1"x4"x2'6"braces.
  2 pieces 1"x6"x5' floor.
  2 pieces 1"x4"x5' front and landing.
  1 piece 1"x14"x5'.
Roosts and dropping board: 2 pieces 2"x4"x6'.
  2 pieces 2"x6"x3'.
  2 pieces 2"x6"x3'.
  2 pieces 1"x12"x6'.
  1 piece 1"x8"x6'.
Windows: 2-6 light 1⅛" sash 8"x10" glass for front.
  2-3 light 1⅛" sash 8"x10" glass for rear.
  5 pieces ⅜"x8"x9' window casing.
Roofing: 3 rolls 3-ply best quality prepared roofing.
Hardware: 3 prs. 4" Tee hinges.
  3 only 6" Tee hinges.
  1 rim lock with knobs.
  3 lbs. 16d nails.
  2 lbs. 10d nails.
  6 lbs. 8d nails.
  3 lbs. 6d nails.
  1 lb. 6d finish nails.
  1 piece of ½" square mesh wire cloth 3' wide and 7' long.

SUMMARY.

Order List and Estimate of Cost.

2 pieces 4"x6"x12' yellow pine dimension. 48 feet @ $32.00 per M.	$1.54
9 pieces 2"x4"x10 No. 1 framing lumber. 8 pieces 2"x4"x12'. 3 pieces 2"x4"x16'. 1 piece 2"x6"x6'. 162 feet @ $30.00 per M.	4.86

1 piece 1"x4"x16' No. 2 pine S2S.	
2 pieces 1"x6"x10'.	
1 piece 1"x8"x6'.	
1 piece 1"x12"x12'.	
1 piece 1"x14"x6'.	
38 1-3 feet @ $40.00 per M	1.13
35 pieces 1"x6"x10' No. 2 matched flooring.	
3 pieces 1"x6"x16' No. 2 matched flooring.	
199 feet @ $38.00 per M	7.56
23 pieces 1"x10"x10' No. 2 shiplap S2S.	
191 2-3 feet @ $36.00 per M	6.90
3 rolls of 3-ply roofing @ $2.50	7.50
Hardware	2.30
Labor	8.00
Total estimated cost	$39.79

It is to be noted that the cost can be made to vary widely by using different grades of materials. Costs will also vary with localities.

THE IOWA COLONY HOUSE.

The following plans are for a colony house which has been used with good success by the poultry section of the Iowa Agricultural Experiment station for several years. It is 2

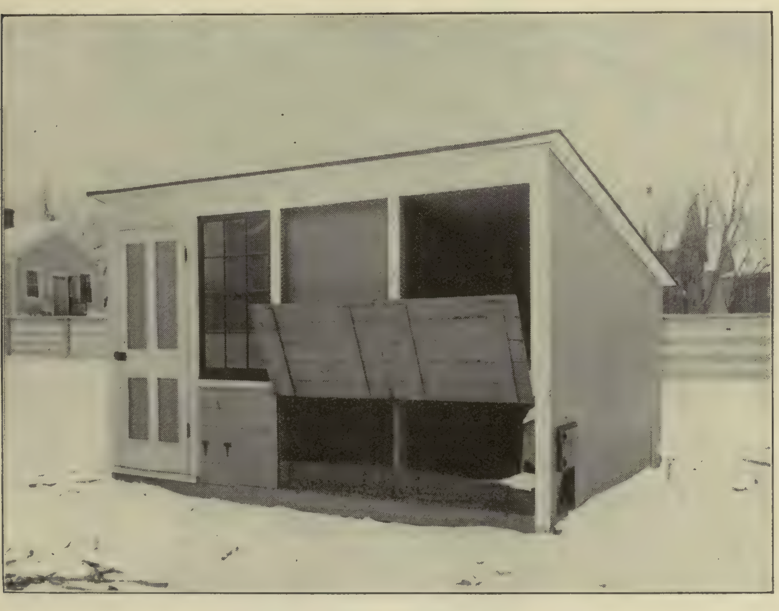


Fig. 3—General View of Iowa Colony House.

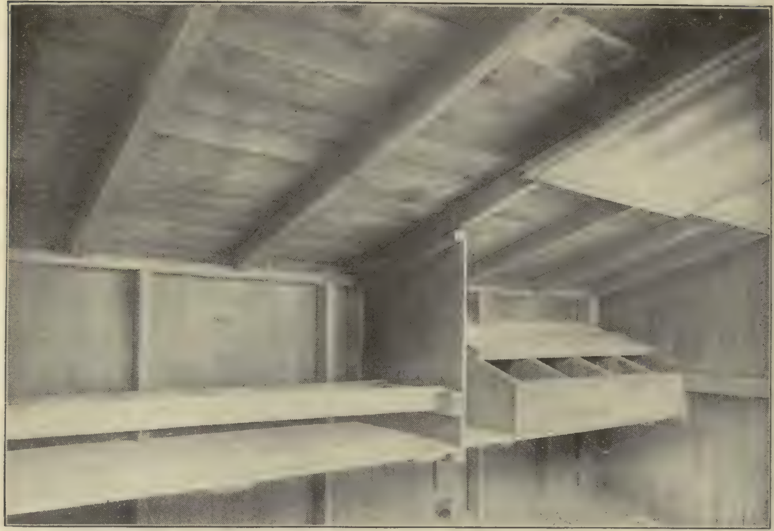
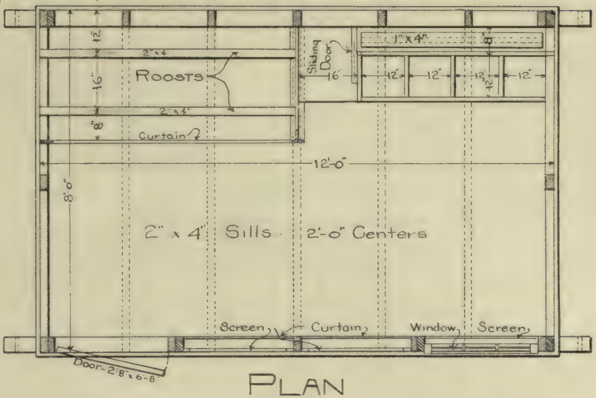


Fig. 4—Interior View of Iowa Colony House Shown in Figure 3 and Plates IV V, Showing Nests and Roosts.

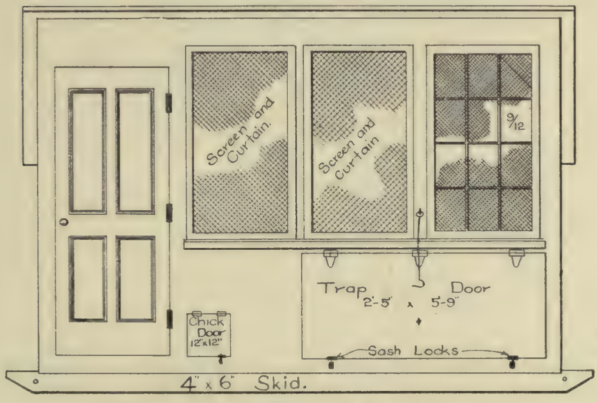
feet longer than the house previously described and will accommodate a correspondingly larger flock. Larger houses have been built upon the same general lines but they have not withstood moving well. A general view of the house is shown in figure 3. The plans are for a house with a shed roof although a combination roof as shown in figure 5 may be used successfully. The house has two curtained openings and one large window in front which provides a large measure of sunlight and ventilation. The illustration shows the window near the door and the drawing shows it at the opposite end. In the latter case, more value is placed upon the sunlight entering through the curtain opening while the curtains are open.

The openings for the curtains are covered with screen and the curtains are hinged at the top and arranged to be swung up to the rafters. The front wall, directly below the window and one of the curtains, is made to open and admit sunlight directly on the floor near the front wall. This trap door is hinged at the top and provided with a hook to hold it up. This opening is also covered with wire cloth or poultry netting. A small door is provided in the front or the end for the fowls.

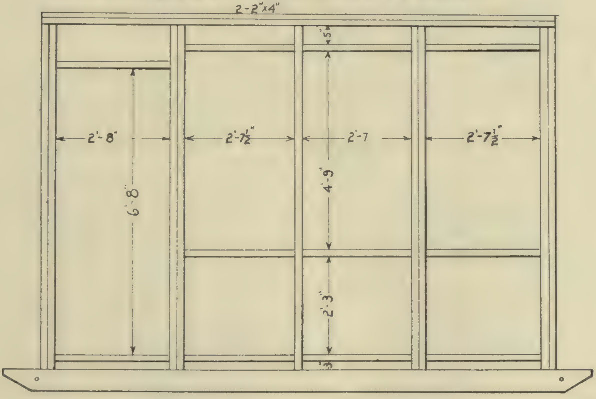
The roosts and dropping board are placed along the back wall about 2 feet from the floor. The nests are placed on a continuation of the dropping board and with the roost fill the back side.



PLAN

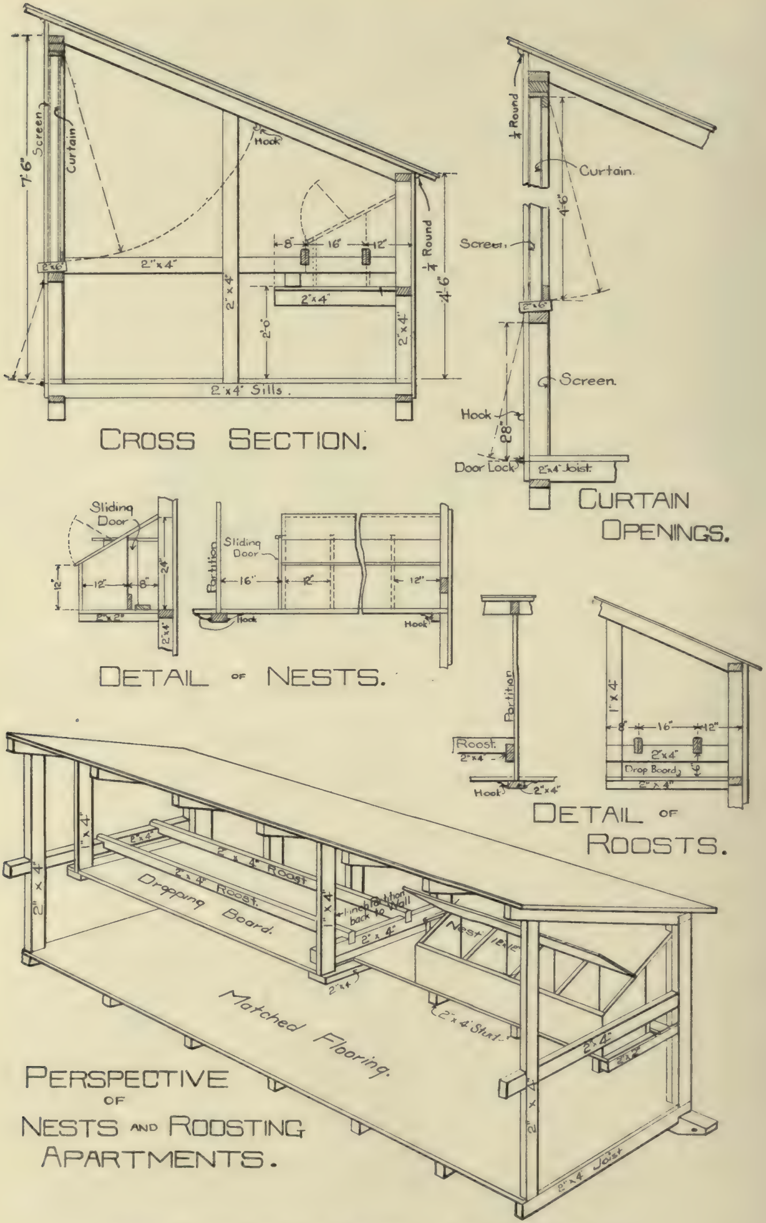


FRONT ELEVATION.



FRAMING OF FRONT

Plate IV—Iowa Colony House.



CROSS SECTION.

CURTAIN OPENINGS.

DETAIL OF NESTS.

DETAIL OF ROOSTS.

PERSPECTIVE OF NESTS AND ROOSTING APARTMENTS.

Plate V—Framing and Details of Iowa Colony House.

CONSTRUCTION.

In many respects the construction of the Iowa poultry house is much similar to the A-shaped house previously described. The skids are made of any good quality of dimension lumber. White or yellow pine is usually selected for this purpose, although other kinds of lumber might resist decay to better advantage. The floor of 1x6 inch flooring is laid on 2x4 inch sills which are slightly notched onto the skids. The framing is of 2x4 inch material, white or yellow pine being satisfactory, and arranged with girts or headers which permit the siding to be nailed on vertically.

The siding is 1x6 inch matched flooring which has been found to be warmer and drier than drop siding or clapboards. The rafters are 2x4 inch material spaced 2 feet apart. The roof is made of 1 inch tongued and grooved sheathing covered with a good grade of prepared roofing. The sheathing which is usually flooring, should be dressed on both sides.

BILL OF MATERIALS.

Skids: 2 pieces 4"x6"x14' yellow pine dimension.
Sills: 7 pieces 2"x4"x8' No. 2 yellow or white pine.
Studs: 9 pieces 2"x4"x8' No. 2 yellow or white pine.
    2 pieces 2"x4"x7' No. 2 yellow or white pine.
    7 or 9 pieces 2"x4"x6' No. 2 yellow or white pine.
Girts and Plates: 5 pieces 2"x4"x12' No. 2 yellow or white pine.
    2 pieces 2"x4"x8' No. 2 yellow or white pine.
Rafters 7 pieces 2"x4"x9' No. 2 yellow or white pine.
Floor: 17 pieces 1"x6"x12' No. 2 white pine flooring.
Siding: 18 pieces 1"x6"x10' No. 2 white pine flooring.
    17 pieces 1"x6"x14' No. 2 white pine flooring.
Sheathing: 21 pieces 1"x6"x12' No. 2 white pine flooring.
Roofing: 1¼ rolls best 3-ply roofing.
Door: 1, 4 panel 2' 8"x6' 8"x1⅛" No. 3 Standard Door.
Window: 1, 12 light 9"x12¼" window.
Finish for curtain frames: 1 piece of 1¼"x6"x12' C finish white pine.
Roosts and Nests: 2 pieces 2"x4"x6'.
    6 pieces 2"x4"x3'.
    2 pieces 1"x4"x12'.
    8 pieces 1"x12"x6'.
    2 pieces ½"x12"x6'.
Miscellaneous: 2 pieces of ¼" rd. 12'.
    2 pieces ¼ rd. 10'.
Hardware: 1½ prs. 3" wrought steel buts for main door.
    4½ prs. 4" Tee hinges for chick door, curtain frames and nests.
    1½ pr. 6" Tee hinges for trap door.
    3 sash locks.
    1 rim lock.
    ½ doz. screw hooks and eyes.
    1 special long hook for trap door.
    25 lbs. 8d nails.
    8 lbs. 10d nails.
    20 lbs. 20d nails.
    20 feet of wire cloth or poultry netting 36 inches wide.

SUMMARY.

Order List and Estimate.

2 pieces 4"x6"x12' Dimension.	
48 feet @ $32.00 per M	$ 1.54
17 pieces 2"x4"x12' No. 1 white or yellow pine.	
3 pieces 2"x4"x14'.	
9 pieces 2"x4"x16'.	
4 pieces 2"x4"x18'.	
308 feet @ $30.00 per M	9.24
18 pieces 1"x6"x10' No. 2 flooring.	
38 pieces 1"x6"x12'.	
17 pieces 1"x6"x14'.	
437 feet @ $38.00 per M	16.61
1 piece 1¼"x6"x12' C finish white pine.	
7½ feet @ $65.00 per M	.49
2 pieces of ¼rd. 12'.	
2 pieces of ¼ rd. 10'.	
44 feet @ 1¢ per foot	.44
1 piece 1"x4"x12' No. 2 white or yellow pine S2S.	
4 pieces 1"x12"x12'.	
52 feet @ $40.00 per M	2.08
1 piece ½"x12"x12' No. 2 white or yellow pine.	
12 sf. feet @ $40.00 per M	.48
1 4 panel 2' 8"x6' 8"x1⅛" No. 3 Standard Door	2.20
1 12 light 9"x12" window	2.75
1½ rolls 3-ply roofing @ $2.50	3.75
Hardware	5.84
Labor	15.00
Total estimate cost	$58.22

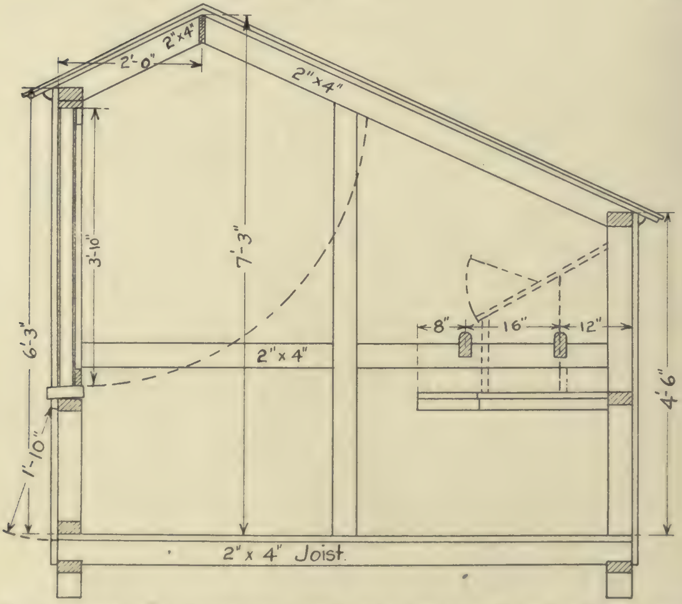


Fig. 5—Showing How Construction Roof may be Adapted to the Iowa Portable Colony House.

THE FARM POULTRY HOUSE.

The house to be described next is a style of house quite widely used and is one well adapted to general farm conditions. It is a permanent structure built upon a substantial foundation and is provided with a cement floor. Attention is called at this point to the general discussion of floors previously given.

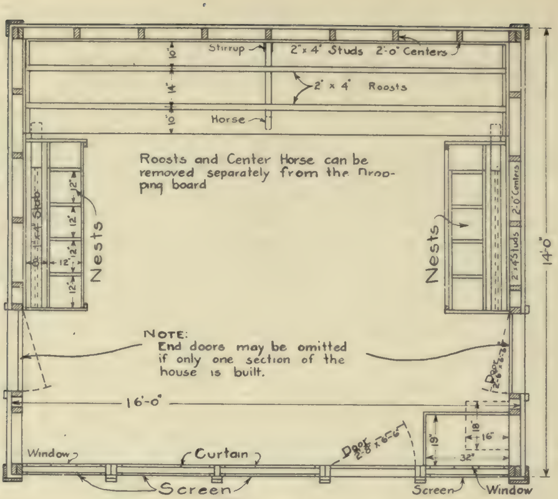
The house as per accompanying drawings, will accommodate in the neighborhood of 50 grown birds, and will permit this size of flock to be cared for with the minimum of labor. The dimensions of the house as per the accompanying drawings, is 14 feet wide and with a 16 foot front. This type of house, however, has been built in varying sizes up to 20 feet by 20 feet in dimension. The roof construction in some of these larger houses has not been made sufficiently strong to resist the heavy snow loads which may come upon them in Iowa. The house has a shed roof with a front, providing adequate window and curtain surface which is arranged to face the south.

CONSTRUCTION.

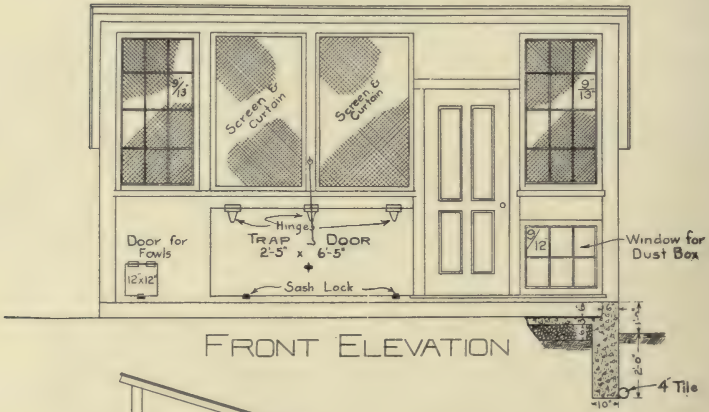
The house as illustrated in the drawings of plates VI, VII, and VIII, is entirely of frame construction. Figure 6 shows the same house built of hollow clay building blocks, 5x8x12 inches in size, and laid so as to make a 5 inch wall. This illustration shows two wide curtains filling the space between the two windows of the front with the door in the end while the drawings show smaller curtains. The arrangement may be varied much more, but in any case there should always be care used to secure a sufficient amount of effective glass and curtain surface in the south front. For a house of the size shown, the front should have two 12x9x12 light windows and two curtained openings of the same size. As in the former houses, these curtains are made of light muslin or cheese cloth tacked onto frames, which are hinged at the top in such a manner as to permit them to be swung up and hooked against the roof.

Another small window, (plate VI), should be provided in the front directly in front of the dust box which is best when made in the form of a 6 inch depression in the house floor. A trap door below the curtains which may be opened during warm days of the summer will add materially to the comfort of the fowls.

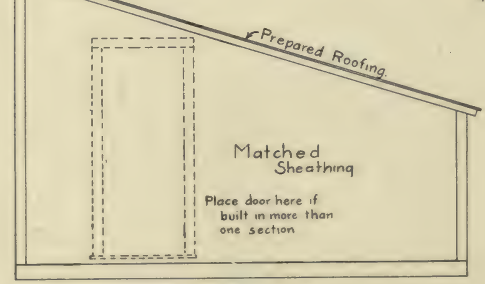
The wall and roof construction of this house is much like that of the Iowa colony house previously described. Matched flooring nailed in place vertically is used for siding and the same material is used for the roof sheathing, being covered with a good grade of prepared roofing. Extreme care should be used in joining the roof to the walls to see that all joints are perfectly air tight. The roosting compartment has matched


Stirrup
2"x 4" Studs 2'-0" Centers
2" x 4" Roosts
Horse
10"
14"
10"
Roosts and Center Horse can be removed separately from the Dropping board
Nests
2"x 4" Stud
12"
12"
12"
12"
12"
Nests
2"x 4" Studs 2'-0" Centers
14'-0"
NOTE: End doors may be omitted if only one section of the house is built.
16'-0"
Door 2'-6"x 6'-3"
18"
16"
19"
32"
Window
Curtain
Door 2'-8" x 6'-6"
Screen
Screen
Window

PLAN

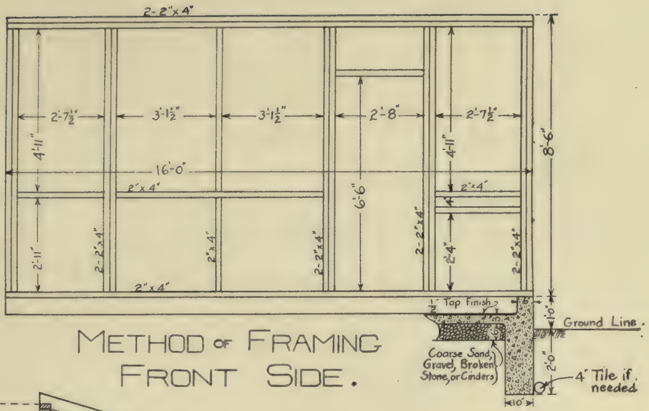


FRONT ELEVATION

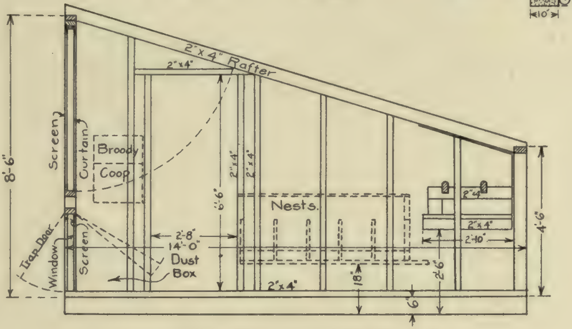


END ELEVATION

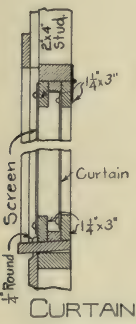
Plate VI—Farm Poultry House.



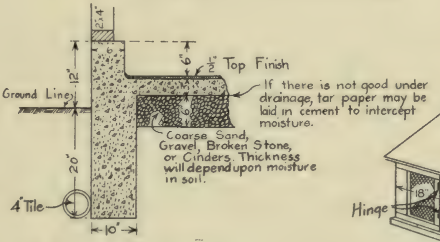
METHOD OF FRAMING FRONT SIDE.



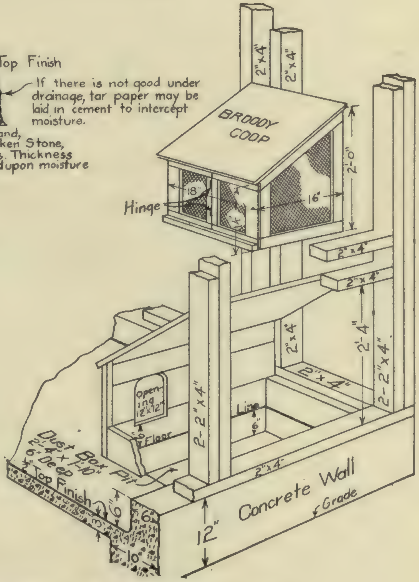
END FRAMING



CURTAIN and SCREEN

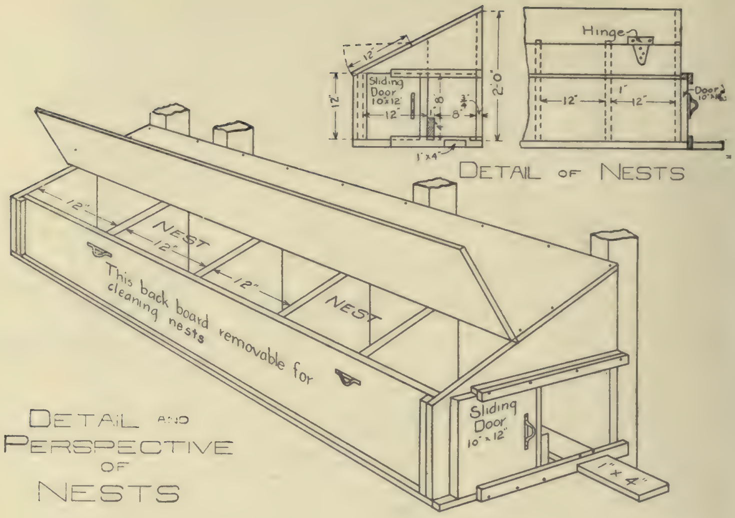

2"x4"
12"
6"
6"
½" Top Finish
Ground Line
If there is not good under drainage, tar paper may be laid in cement to intercept moisture.
Coarse Sand, Gravel, Broken Stone, or Cinders. Thickness will depend upon moisture in soil.
20"
4" Tile
10"

FOUNDATION



PERSPECTIVE OF BROODY COOP AND DUST BOX

Plate VII—Framing and Details of Farm Poultry House.



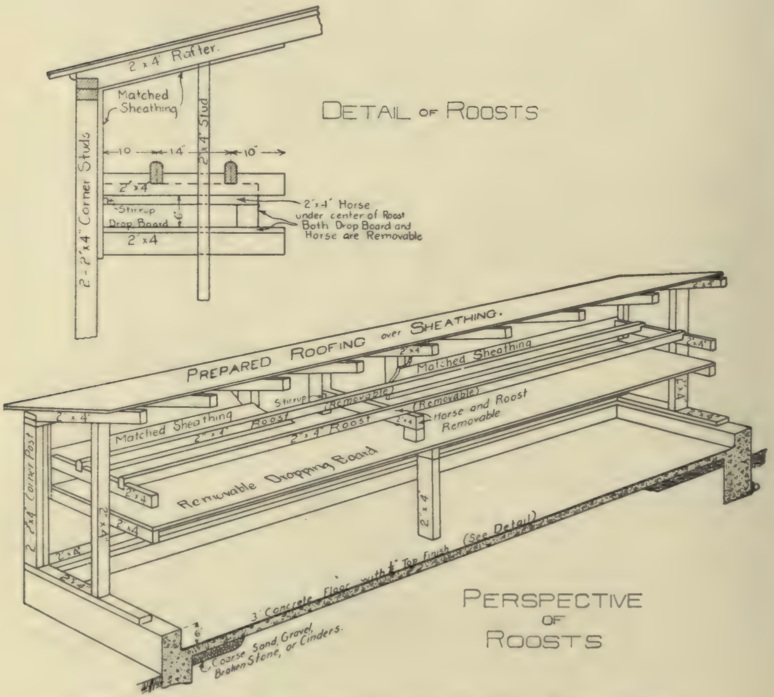


Plate VIII—Nest and Roost Details—Farm Poultry House.

sheathing surrounding it and, if desired, a muslin curtain may be provided in front of the nests.

ROOSTS AND NESTS.

The roosts are placed at the back side of the house and together with the dropping board, are made removable for cleaning.

The nests are made in two sections where several are needed and are placed on the side walls.

The nests are similar in design to those described for the Iowa colony house.

BILL OF MATERIAL AND ESTIMATE OF COST FOR FARM POULTRY HOUSE, FRAME CONSTRUCTION.

Size of house, 14x16 feet.	
Foundation and floor: Excavation	$ 2.50
Foundation wall. 5 yds. concrete @ $4.00	20.00
Gravel for filling. 4 yds. @ $1.00	4.00
Cement floor. 224 sq. ft. @ 12½¢	28.00
Water proof layer Asphalt paint 1 coat	3.00
Drain tile. 75 feet @ 2.5¢	1.86
	$59.36
Frame.	
Sills: 2 pieces 2"x4"x16' No. 2 yellow or white pine.	
2 pieces 2"x4"x14' No. 2 yellow or white pine.	
Studs: 5 pieces 2"x4"x16' No. 2 yellow or white pine.	
8 pieces 2"x4"x14' No. 2 yellow or white pine.	
5 pieces 2"x4"x10' No. 2 yellow or white pine.	
Plates: 3 pieces 2"x4"x16' No. 2 yellow or white pine.	
Girts: 2 pieces 2"x4"x16' No. 2 yellow or white pine.	
2 pieces 2"x4"x14' No. 2 yellow or white pine.	
Rafters: 2 pieces 2"x4"x16' No. 2 yellow or white pine.	
Total 295 feet @ $30.00	$ 8.85
Siding: 400 ft. 1"x6" D & M flooring No. 2 pine.	
Sheathing: 320 feet flooring No. 2 white pine.	
Inside sheathing: 120 feet flooring No. 2 white pine.	
840 feet @ $38.00 per M	31.92
Roofing: 3 rolls best quality 3-ply @ $2.50	7.50
Mill work: 2 windows 12 lights 9x12	5.50
1 sash 6 lights 9x12	1.40
1 door 2' 8"x6' 8"x1⅛" No 3	2.20
4 curtain and screen panes, 3' 1½"x5' 0"	3.00
2 pieces of ¼" rd. 16'.	
2 pieces of ¼" rd. 14'	.60
3 yds. muslin @ 10¢	.30
Roosts: 3 pieces 2"x4"x16' No. 2 white or yellow pine.	
32 feet @ $30.00.	
3 pieces 1"x12"x16' No. 1 white pine.	
48 feet @ $46.00	3.17
Nests: 4 pieces 1"x12"x10' No. 1 white pine.	
1 piece 1"x4"x12'.	
14 feet @ $46.00.	
2 pieces ½"x12"x10'.	
1 piece ½"x6"x10'.	
15 surface feet @ $30.00	1.09
Dust Box: 1 piece 1"x12"x16' No. 2 white pine.	
16 feet @ $38.00	.61

Hardware: 1½ pr. 3 inch wrought steel butts @ 15	.23	
2½ pr. 4 inch Tee hinges @ 10¢	.25	
3½ pr. 6 inch Tee hinges @ 15¢	.52	
1 rim door lock @ 35¢	35	
3 sash locks @ 10¢	.30	
4 lbs. 5d nails.		
25 lbs. 8d nails.		
15 lbs. 20d nails @ 3½¢	1.54	
80 sq. ft. of poultry net or wire cloth @ 6¢	4.80	
Total cost of hardware	7.99	
Total cost of materials		$133.79
Labor, estimated at 30 per cent of materials		40.15
Total cost		$173.64

FARM POULTRY HOUSE—MASONRY CONSTRUCTION.

Where the walls are built of hollow vitrified clay building blocks with the window openings shown in plate seven, the bill of materials and estimate of cost will be as follows: The estimate is for 5x8x12 inch blocks laid so as to make a 5 inch wall. Four inch blocks may be used.

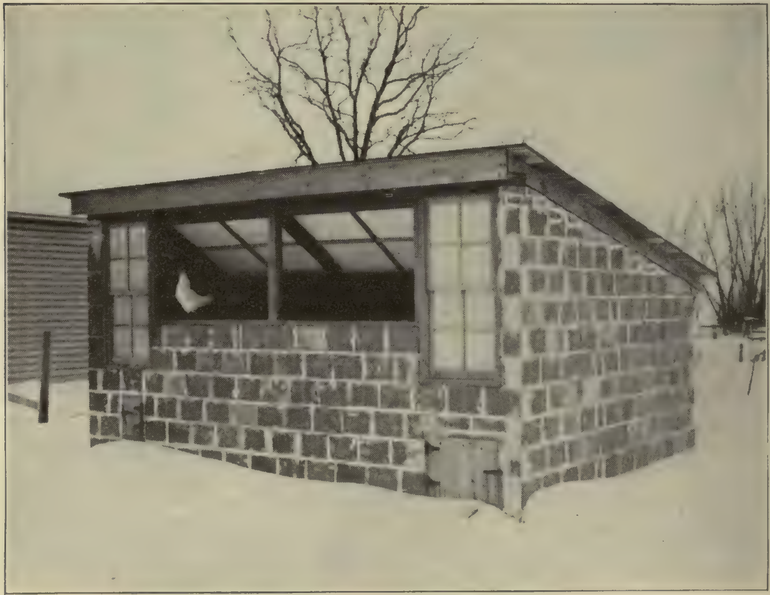


Fig. 6—Farm Poultry House Built of Hollow Clay Building Blocks.

This house is similar to that shown in Plates VI, VII and VIII, and proved to be quite satisfactory during the past winter.

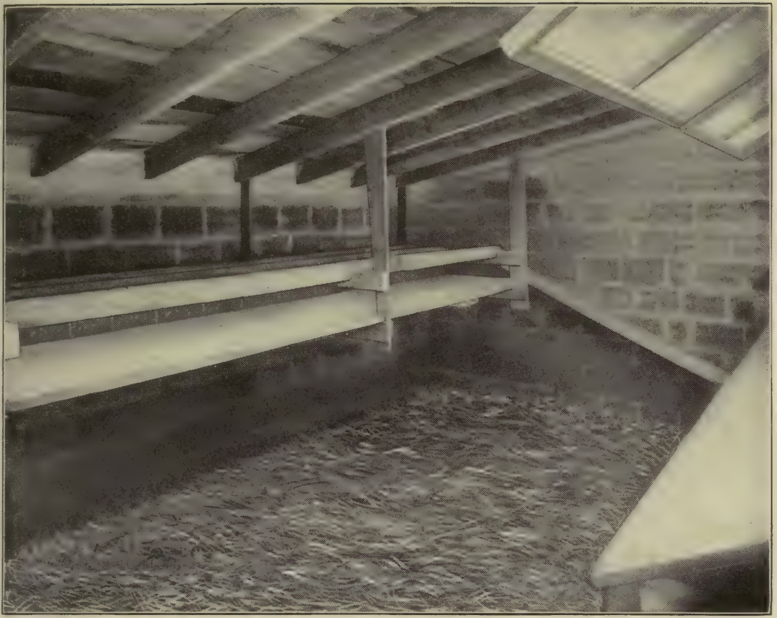


Fig. 7—Interior View in House shown in Figure 6.

BILL OF MATERIALS AND ESTIMATE OF COST.

Foundation as before	$ 59.36
Window and door frames:	
8 pieces 2"x4"x16' No. 2 yellow or white pine 85 feet @ $30.00	2.55
Rear plate:	
1 piece 2"x4"x16' No. 2 yellow or white pine 11 ft. @ $30.00	.33
Front trap door:	
4 pieces 1"x6"x14' No. 2 white pine flooring 28 feet @ $38.00	1.06
Rafters as before	8.85
Roof sheathing as before	12.16
Roofing as before	7.50
Mill work as before	13.00
Muslin as before	.30
Roosts as before	3.17
Nests as before	1.09
Dust box as before	.61
Hardware as before	7.99
375 5"x8"x12" hollow vitrified clay bld. blocks @ $40.00 per M	15.00
40 corner blocks @ 5¢	2.00
Mortar	4.00
	$138.97
Labor 30%	41.69
Total	$180.66

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April 7, 1914.

POULTRY HOUSE CONSTRUCTION.

By Alfred R. Lee,
Junior Animal Husbandman in Poultry Investigations, Animal Husbandry Division.

POULTRY HOUSES AND FIXTURES.

This article explains the essential principles of poultry-house construction, showing pictures of houses and fixtures which have given satisfaction in various sections of the country, with their plans and specifications; and contains hints on construction which will assist the poultryman in planning and erecting his buildings.

ESSENTIALS IN POULTRY HOUSES.

The prime essentials in poultry houses are fresh air, dryness, sunlight, and space enough to keep the birds comfortable. No particular style of house is peculiarly adapted to any section of this country. A house which gives satisfaction in Maine will also give good results in Texas or California, but it is preferable to build more open and consequently less expensive houses in the South than in the North. The best site for the poultry house depends principally on the local conditions. The location should have good water and air drainage, so that the floor and yards will be dry, while the house should not occupy a low pocket or hollow in which cold air settles, and it should be situated for convenience in management and adapted to the available land. Wherever possible a southern or southeastern exposure should be selected, although this is not essential if there is any good reason for facing the house in a different direction.

Poultry can be raised successfully on any well-drained soil. A light loam, which will grow good grass, is well adapted for this purpose; while a very light, sandy soil, through which the water leaches freely, will stand more intensive poultry conditions, but most of the green feed for the fowls kept on such a soil will have to be purchased. A heavy clay or adobe soil is not as well adapted to poultry raising, as such land does not drain readily and it is much more difficult to keep the stock healthy. Long stationary houses, or the intensive system,

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Note.—This bulletin gives practical instruction for locating and constructing poultry houses. It is adapted for general circulation.

saves steps, but it is easier to keep the birds healthy and to reproduce the stock under the colony system where the birds are allowed free range. Breeding stock, and especially growing chickens, should have an abundance of range, while hens used solely for the production of market eggs may be kept on a very small area with good results. The colony house system necessitates placing the houses, holding about 100 hens, from 200 to 250 feet apart, so that the stock will not kill the grass. The colony system may be adapted to severe winter conditions by drawing the colony houses together in a convenient place at the beginning of winter, thus reducing the labor during these months.

YARDS AND FENCES.

Fences, dividing the land into yards, increase the cost of equipment, labor, and maintenance, and there should be as few fences as possible, as land can be cultivated and kept sweet more easily if not fenced, and the value of fresh, sweet land for poultry can hardly be overestimated. A grass sward can be maintained on good soil by allowing 200 to 250 square feet of land per bird (217 or 174 birds to the acre), while more space is necessary on poor or light land. A larger number of fowls are usually kept to the acre where double yards are used and the land is frequently cultivated. Plymouth Rocks and the heavy meat breeds in small yards require fences 5 to 6 feet high, while a fence 6 to 7 feet high is necessary for Leghorns. The upper 2 feet of the fence for the latter may be inclined inward at an angle of 30 degrees, or a strand or two of barbed wire may be used on top of the regular wire to help keep them confined, while it is sometimes necessary to clip the wing feathers of one wing of those birds which persist in getting out. It is not advisable to use a board or strip along the top of the fence, as hens will often fly over one so constructed.

Posts may be set or driven into the ground. They should be set 8 to 10 feet apart with common poultry netting, or 16 to 20 feet with woven wire. Corner posts should be about 8 inches in diameter, and be set 4 feet in the ground, while intervening posts may be 4 or 5 inches in diameter and set 3 feet in the ground. That part of the post which is set in the ground may be charred or treated with some wood preservative to advantage, while corner posts should be firmly braced or set in cement.

CONSTRUCTION OF POULTRY HOUSES.

A house constructed for the convenience of the attendant will have enough cubic air space provided 2 to 5 square feet of floor space is allowed per fowl. Fresh air should be secured by ventilation rather than by furnishing a larger amount of cubic air space than is required for the convenience of the attendant. The necessary amount of floor space depends upon the system, on the size of the pens, the weather conditions, and the size of the birds. More birds can be kept on a small floor area under the colony than on the intensive system, where the colony system is used in a mild climate and the hens have free range throughout most of the year. Colony houses holding from 30 to 75 hens are about as large as can be easily moved, but larger numbers may be kept in one flock in a long house. Flocks of from 60 to 150 are well adapted to the average conditions for the production of market eggs. Large numbers require less labor, fewer fences, and a lower house cost than small flocks, but there is a greater chance for disease and the individual hen receives less attention. The cost of housing poultry depends upon many conditions, such as price of lumber, style of house, amount of floor space allowed per bird, etc. Substantial poultry houses can be built for from 80 cents to $1.60 per head, including labor. The cost of material per head will vary from 50 cents to $1.

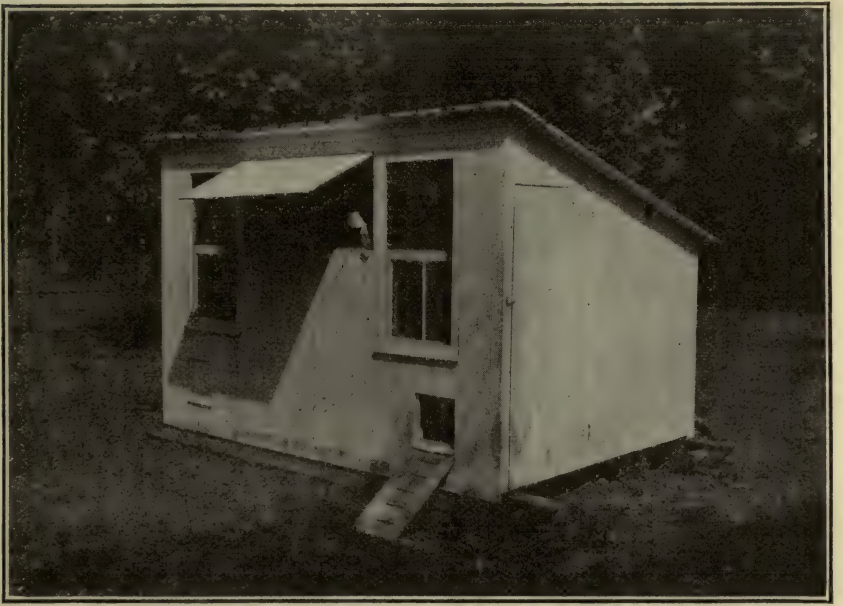


FIG. 1.—Colony house used at Government Poultry Farm, Beltsville, Md.

ROOF AND FRONT.

The roof is the most expensive but a most important part of the poultry house, and should be water-tight. Shingle roofs should have a one-third pitch, while those covered with paper or metal may have a less pitch, or be almost flat; however, the greater the slope the longer the life of the roof. Different types of roofs and the comparative amount of surface to be covered are illustrated in figure 5. The shed or single-slope roof is adapted to houses up to 16 feet in

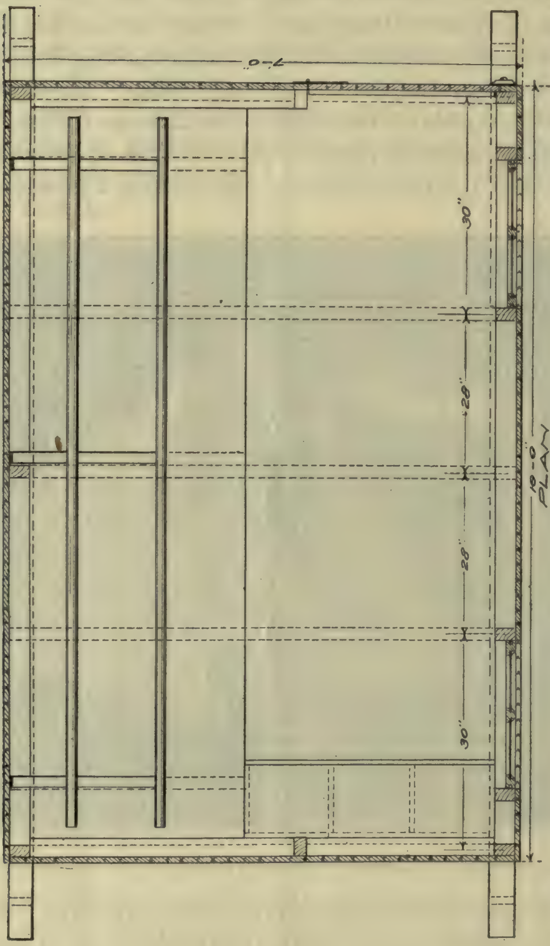
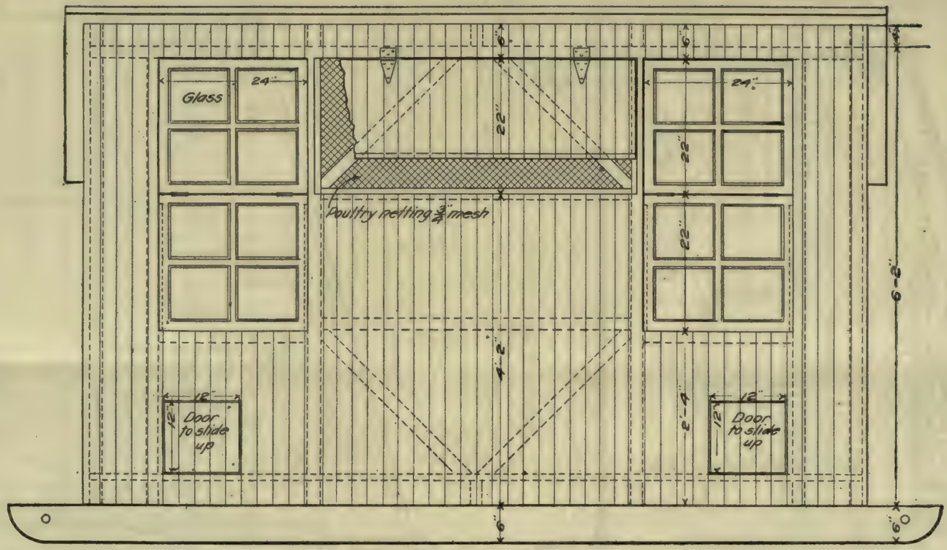


FIG. 2.—Floor plan of colony house used at Government Poultry Farm, Beltsville, Md. Capacity, 25 hens.

BILL OF MATERIAL FOR COLONY HOUSE

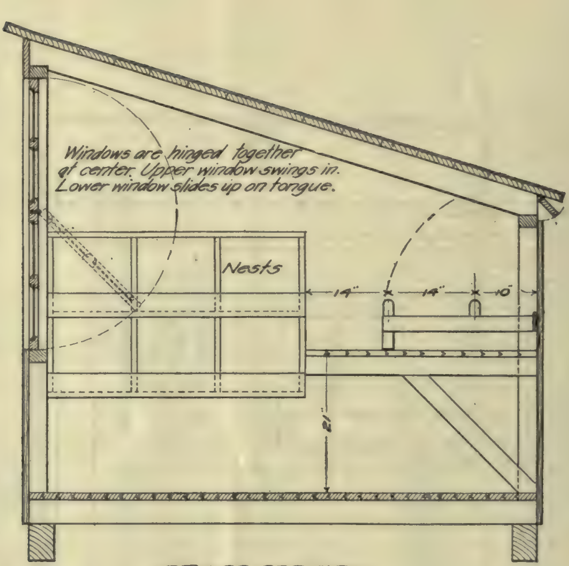
USE	SIZE	NO. OF PIECES	LENGTH FEET	BOARD MEASURE
Sills (runners)	4"x6"	2	12'	48'
Joists	2"x4"	3	14'	28'
Studs & braces	2"x3"	13	12'	78'
Rafters	2"x4"	3	16'	32'
			Total	186'
7/8" Matched flooring (floor & sides)				340'
7/8" Sheathing, surfaced one side				100'
Roofing paper, 1 roll.				
Windows hardware etc.				



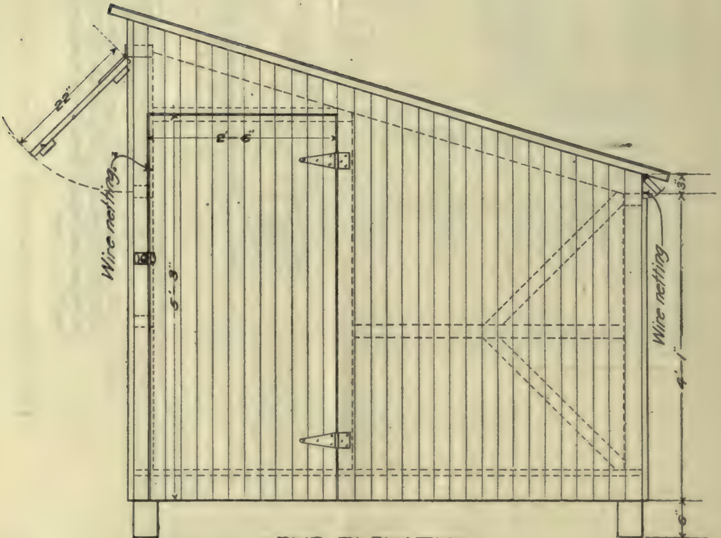
FRONT ELEVATION

Note: Sills (runners) 4"x6"; joists & rafters 2"x4"; plates studs & braces 2"x3"; siding & flooring ⅞" tongue & groove material and roof ⅞" material covered with roofing paper.

Fig. 3.—Front elevation of colony house used at Government Poultry Farm, Beltsville, Md. Capacity, 25 hens.


Windows are hinged together
at center. Upper window swings in.
Lower window slides up on tongue.
Nests
14"
14"
10"
21"

CROSS SECTION



END ELEVATION

FIG. 4.—Cross section and end elevation of colony house used at Government Poultry Farm, Beltsville, Md. Capacity, 25 hens.

width. It is one of the easiest styles to construct. It allows a high front to the house, and furnishes a northern slope for the roof on which roofing paper will last longer than on a roof which faces the south. The combination and semimonitor roofs are adapted for buildings from 16 to 24 feet wide, while either of these styles, or the monitor and the gable roof, may be used for wider buildings. The combination roof on a house over 16 feet wide gives the best head room at the least cost, reduces the amount of surplus air space, and gives a neat appearance to the buildings; while the semimonitor and monitor types are best for wide houses which have a central alley, particularly brooder houses. The semimonitor house usually faces south, while the monitor type of roof is frequently used on buildings facing east or west. The gable roof is used extensively for two-story buildings, for brooder houses, and for incubator cellars. This style of roof is usually ceiled at or slightly above the eaves, or the gable may be filled with straw or some kind of absorbent material, which tends to keep such houses dry and warm. The A-shaped roof is used for growing coops and colony houses which, with a wall 18 inches high, provides a large amount of floor space with a minimum amount of lumber, but increases the roof surface, which is the most expensive part of the house.

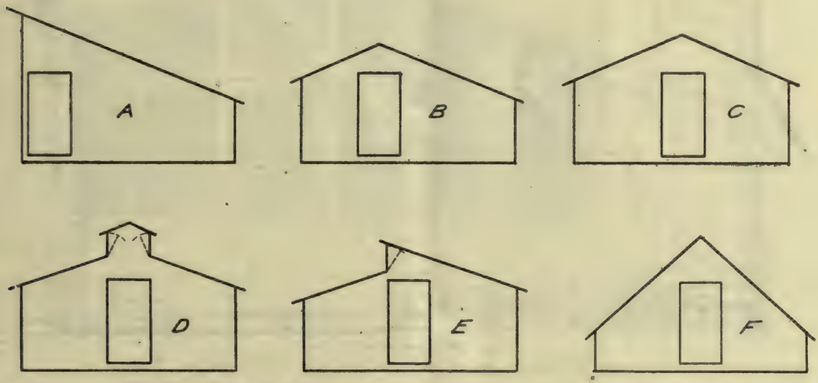


FIG. 5.—Types of roofs for poultry houses. *A*, shed; *B*, combination; *C*, gable; *D*, monitor; *E*, semimonitor; *F*, A-shaped.

A large amount of glass in the front of the house makes it warm during the day and cold at night, as glass radiates heat very rapidly. Unbleached muslin, or a light weight of duck cloth, is used for curtains in the fronts of poultry houses. This cloth should be thin enough to allow a slow circulation of air without a draft, which object is defeated by using too heavy a grade of duck or by oiling or painting the cloth. The front of the house should be high enough so that the windows or openings will allow the sun to shine well back during the winter. The depth which the sun's rays shine onto the floor of

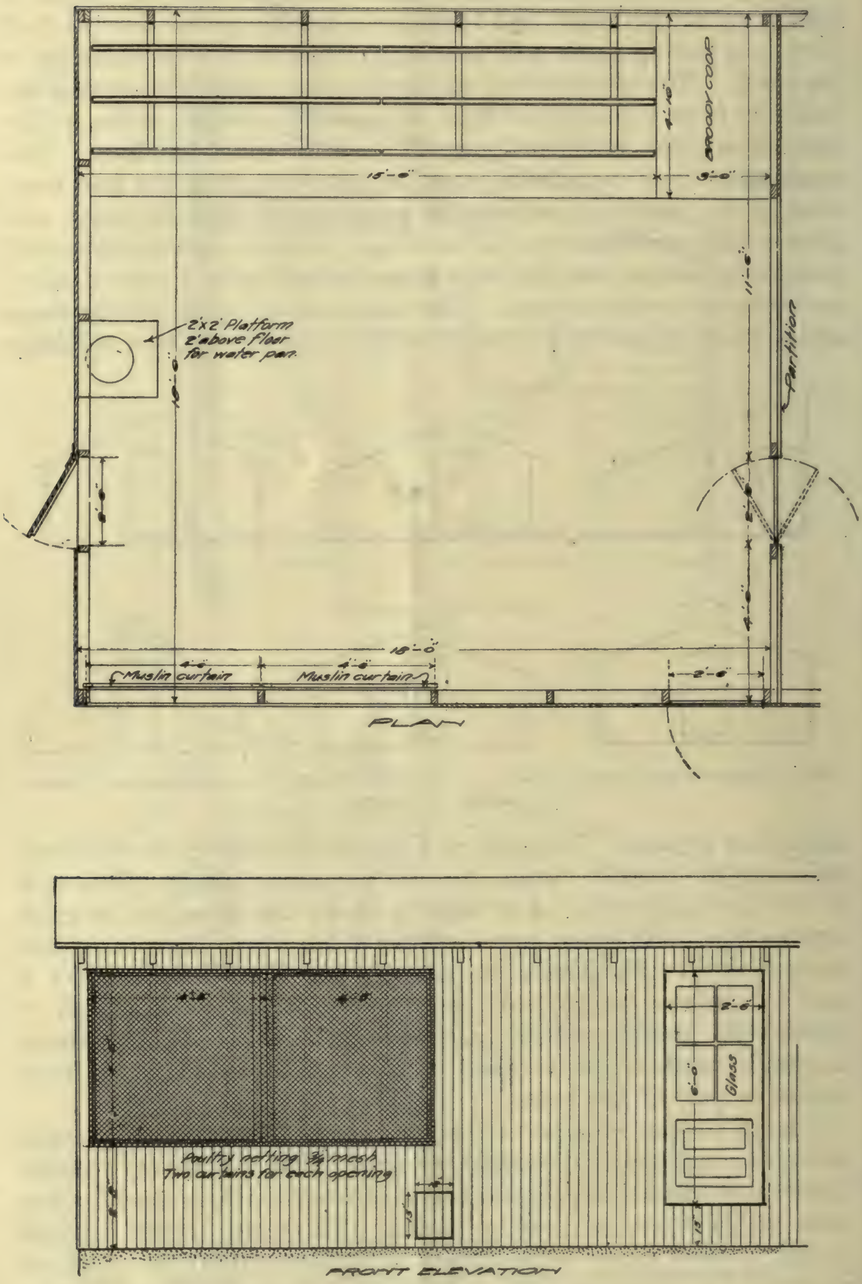


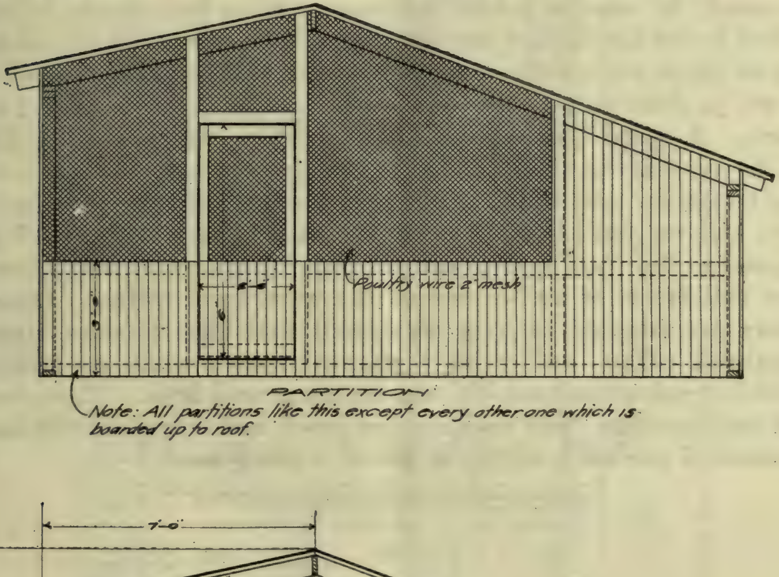
FIG. 6.—Floor plan and front elevation of laying house used at Government Poultry Farm, Beltsville, Md. Capacity, 500 hens.

BILL OF MATERIAL FOR
LAYING HOUSE 18'X 108'

USE	SIZE	NO OF PIECES	LENGTH FEET	BOARD MEASURE
Sills	2"X4"	30	12'	240'
Plates	2"X4" doubled	44	12'	352'
Ties for rafters	1X5"	30	16'	220'
Rafters	2"X6"	56	14'	784'
Rafters	2"X6"	56	10'	560'
Studs	2"X4"	38	12'	304'
Studs (front)	2"X4"	28	8'	150'
Roosts	2"X3"	36	8'	144'
			Total	2754'
Sheathing surfaced one side for roof				2860'
Matched flooring for walls partitions & droppings board				3200'
Boards planed both sides for nests				300'

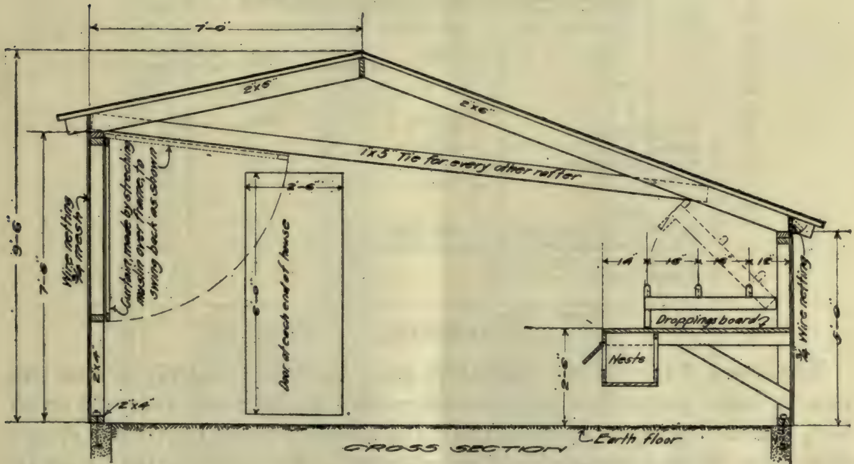
340 Running feet of 1"x3" furring for curtain frames.
300 Sq. ft. of 3/4 mesh wire for front.
300 Sq. ft. of 2" mesh wire for partitions.
350 Sq. ft. of muslin cloth for curtains.
Prepared roofing paper to cover 2700 sq. ft.
8 Outside doors.
Hardware (hinges, nails, staples, etc.)

Cement wall or posts (either cement or wood) for foundation. If posts are used the sill should be 4"x4" instead of 2"x4" thus doubling the number of feet (board measure) required for sills.



PARTITION

Note: All partitions like this except every other one which is boarded up to roof.



CROSS SECTION

FIG. 7.—Partition and cross section of laying house used at Government Poultry Farm, Beltsville, Md. Capacity, 500 hens.

the house in the vicinity of Washington, D. C. (latitude 40° N.), on January 1, is given in the accompanying table.

Top of windows.	Depth of sun.	Top of windows.	Depth of sun.
Ft. in.	*Ft.*	*Ft. in.*	*Ft.*
3 6	8	6 2	14
4 5	10	7 1	16
5 4	12	7 11	18

FLOOR.

The best kind of a floor depends upon the soil and the use of the house. On light, sandy, well-drained soils a dirt floor is satisfactory, especially for small or colony henhouses. Such floors should be from 2 to 6 inches higher than the outside ground surface, and it is advisable to renew them each year by removing the contaminated surface down to clean soil, and to refill with fresh sand or fine gravel and earth. A board floor is generally used where the level of the floor in the house is from 1 to 3 feet above the ground surface and in portable houses on land which is not well drained. Board floors harbor rats and rot quickly, and should be raised some distance off the ground so that cats or dogs can get under them, which also allows a free circulation of air to prevent the wood from rotting. Cement floors are adapted to long permanent buildings, brooder houses, incubator cellars, and to all permanent houses where an artificial floor is required and can be built on the ground level. These floors are easy to clean, very sanitary, rat proof, and comparatively inexpensive, if one has a supply of gravel or sharp sand.

Bill of material for colony growing coop.

Use.	Size.	Number of pieces.	Length.	Board measure.
	Inches.		*Feet.*	*Feet.*
Sills (runners)	3 by 4	2	8	16
Joists	2 by 4	2	10	14
Studs and braces	2 by 3	8	12	48
Rafters	2 by 4	3	12	24
Total				102
⅞-inch matched flooring (sides and floor)				175
⅞-inch sheathing surfaced on one side (roof)				36
Roofing paper, one-half roll.				
Hinges and hardware.				

PARTITIONS.

The lower 3 feet of all partitions may be solid, entirely across the pen, or solid partitions across the houses may be made every 30 or 35 feet, depending upon the length of the house. Solid partitions closer than this are unnecessary and interfere with free circulation of air in warm weather.

ROOSTS AND DROPPING BOARDS.

The interior fixtures of the pens should be simple, portable, and inexpensive. Roosts are usually placed next to the end or back

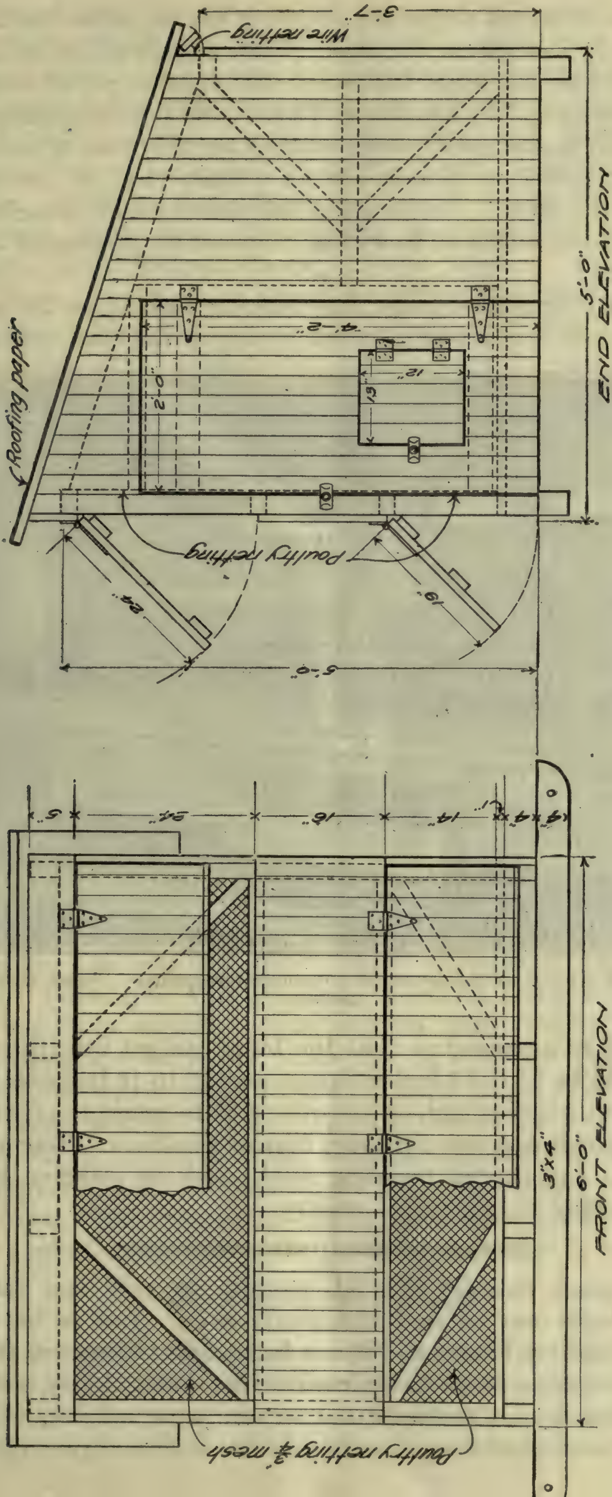


FIG. 8.—Colony growing coop used at Government Poultry Farm, Beltsville, Md.

walls, 6 to 10 inches above the dropping boards, while the latter are from 2 to 2½ feet above the floor. They should all be on the same level, otherwise the birds will crowd and fight to get on the highest roost. Scantling 2 by 3 inches or 2 by 4 inches, with the upper edges rounded off, makes good roosts with either the wide or narrow surface up. Allow 7 to 10 inches of roost space per fowl, according to the size of the birds. Roosts should be placed about 15 inches apart, but the outside ones may be within 10 inches of the edge of the dropping boards.

Nests may be placed under the dropping boards, on the partition walls, or in any convenient place where they do not take up floor space, and should be arranged so that the birds can get into them easily. They should be 12 to 14 inches square and 12 to 16 inches high, with a strip about 4 inches high on the open side to retain the nesting material. Provide one nest for every four or five hens. Trap nests are essential in any careful breeding work, such as pedigree breeding, or the breeding of exhibition poultry.

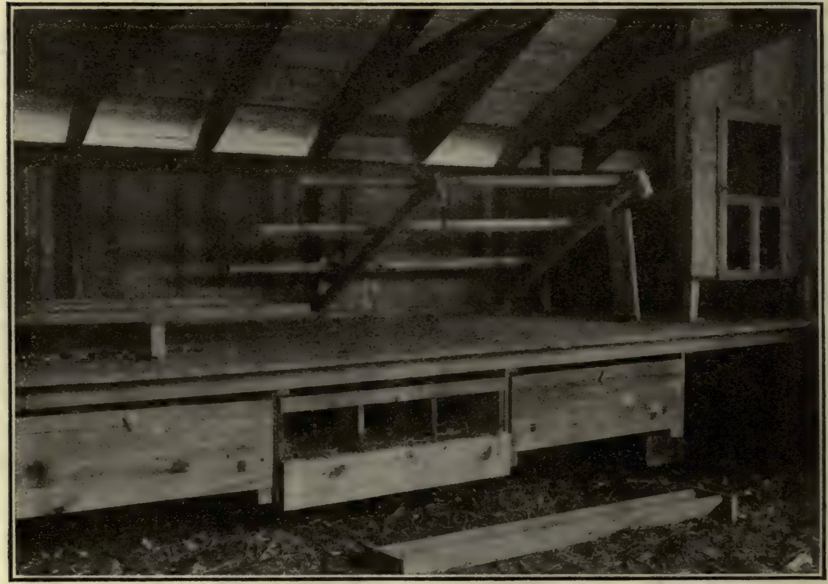


FIG. 9.—Interior of pen in laying house used at Government Poultry Farm. Roosts, dropping board, and nests.

KINDS OF MATERIAL USED FOR BUILDING.

Houses made entirely of solid concrete are cold and damp, but concrete blocks may be used with good results. Hollow tile makes a very good poultry house, and it can be bought in some sections at a price which compares favorably, considering its durability, with wood. This construction is well adapted to incubator cellars and brooder houses, or to any buildings requiring double walls and good insulation.

All kinds of wood are used in building poultry houses, and any durable lumber which is available for that purpose may be used. The lumber which is to be used for the outside construction should be well seasoned, otherwise the shrinkage will leave cracks in the walls. Hemlock, spruce, western white pine, and Virginia pine are commonly used for sheathing in the North, hard pine in the Gulf States, and redwood or Oregon pine on the Pacific coast. Redwood, cypress, and white pine are the best materials for siding, while clear spruce, Oregon, Georgia, North Carolina, and Virginia pine are also used. Chestnut is used locally for sheathing and siding in some parts of New England and the Alleghenies, while local pines of different species are available for rough lumber in many sections. Spruce, white pine, northern yellow pine, Georgia, Virginia, and North Carolina pine are used for light framing (studs, rafters, sills, plates, purlins, etc.). Oregon and Georgia pine are used for sills and runners. The best shingles are made of redwood, cypress, and cedar; and white pine is also used. Asbestos shingles are quite durable, but more expensive than wooden ones. Cedar, chestnut, redwood, cypress, and locust make the best posts. Second-hand lumber or lumber from large packing or piano boxes can be used in building small poultry houses. Lumber comes in even lengths, usually 10, 12, 14, and 16 feet long, and if second-hand lumber is to be utilized, it may be advisable to plan the house according to the length of the lumber. Care should be taken in ordering a bill of lumber to secure lengths which will cut to the best advantage in building.

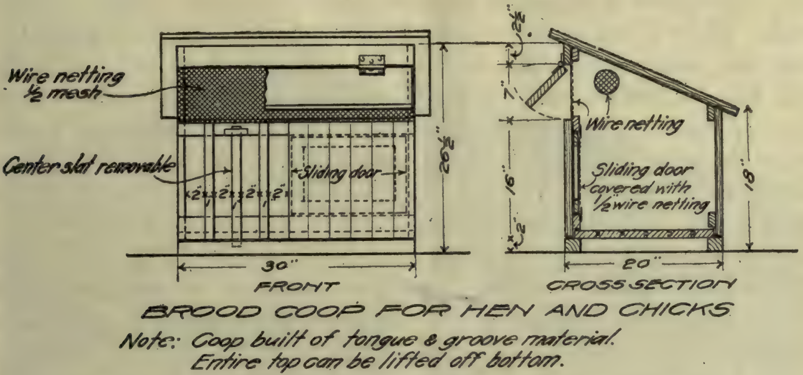

Wire netting ½ mesh
Center slat removable
2" 2" 2" 2"
Sliding door
20½"
30"
FRONT
2½"
7"
16"
2"
Wire netting
Sliding door covered with ½ wire netting
18"
20"
CROSS SECTION
BROOD COOP FOR HEN AND CHICKS
Note: Coop built of tongue & groove material.
Entire top can be lifted off bottom.

FIG. 10.—Brood coop for hen and chicks, used at Government Poultry Farm.

FRAMEWORK OF THE BUILDING.

The sills are placed on posts, stones, or cement supports, or directly on cement walls. Wooden floors should be from 10 to 18 inches above the ground, while cement floors are built directly on it, but the site should be elevated enough so there is good drainage away from the building. Posts should be from 6 to 8 inches in diameter, placed 6 to 8 feet apart and set 2 to 3 feet in the ground or below the frost level, which varies with the locality. Sills may be 2 by 4, 4 by 4, and 4 by 6 inches, depending upon the size and construction of the building; 2 by 3 or 2 by 4 inches are heavy enough for colony houses or those of light, single-wall construction, which are not over 10 or 12 feet deep and 4 to 7 feet high. Sills 4 by 4 inches are used for larger buildings and for houses with double walls. Runners 3 by 4 or 4 by 6 inches are used as sills for portable houses, as the latter require heavy framework. Sills 4 by 6 inches are used in two-story henhouses or other large poultry buildings, and should be set on edge unless on a cement or stone wall, when a lighter sill may be used which is set flat. The posts or supports must set closely together if light sills are used. Floor joists may be 2 by 4, 2 by 6, or 2 by 8 inch lumber, their size depending somewhat on the amount of weight which the floor has to sustain, and should be set from 16 to 20 inches apart. Fix one line or side of the proposed house, and with this as a base locate the other corner posts by using the 6, 8, and 10 foot combination, measuring 6 feet from the corner of the fixed line and 8 feet from the same corner at right angles, which point is fixed by a rule 10 feet long running from the 6-foot mark of the fixed line to the end of the 8-foot line, thereby making a square corner. A triangle whose sides are 6, 8, and 10 feet long, respectively, contains a right angle opposite the hypothenuse or diagonal side. For small buildings drive a stake at the selected corner for the house, and nail a straightedge to this stake at the desired height of the posts or floor, using a spirit level on this straightedge to mark the posts at the same level. A transit is generally used in laying out large buildings.

The studding or uprights are placed on the sill and should be set plumb with a spirit level and be well braced until sheathed. Sills are halved or spliced and nailed together at the joints or ends. The studding is toenailed to the sills, while the plates are spiked to the top of the studding. Studding is set 2 to 4 feet apart on the rear walls and ends of poultry houses and is placed to fit the windows, curtains, and doors in the front and ends. Less studding is required if the building is boarded up and down rather than horizontally, as in the former case only a few studs with cross-studding or ties are required. The studs should be placed so that the lumber will cut to good advantage, as lumber usually comes in even rather than odd lengths. Studs 2 by 3 or 2 by 4 inches are commonly used, the former for small or colony houses and the latter for larger buildings. Plates are made of 2 by 4 inch scantling or 2 by 4 inch scantling doubled and spiked together and are usually laid flat on the top of the studs, while the corner studs may also be doubled. Rafters may be of 2 by 4, 2 by 5, or 2 by 6 inch lumber; the first is used only in light buildings; the first and second in buildings where the rafters are not over 14 feet long; and the latter in climates where the roofs must sustain much weight of snow. It is advisable to use a purlin in buildings where rafters are over 14 feet long. Purlins are usually made of 2 by 6 or 2 by 8 inch material set on edge. They are placed lengthwise of the house above halfway between the front and back walls and make a support for the rafters. A ridge board may be placed between the ends of the rafters at the apex of the house to keep the ridge straight and even. Collar beams or crossties 1 by 6 or 1 by 8 inches are used to connect and strengthen the front and rear rafters on two-pitch, gable, or combination roofs. They should be placed as low as possible on the rafters, so as to stiffen the frame, but not to interfere with head space. One pair of rafters may be set in position and the rest marked from these, or a square may be set on the rafter, using the inches on the square to correspond to the feet in the slope of the roof and the rafters marked from the angle thus obtained, so that they will fit correctly. Rafters should only be notched or cut enough to fit tightly where they rest on the plates; not ovei 1 inch, as deep notching weakens them. They are usually placed 2 or 2½ feet apart from center to center, so that the sheathing may be used with the least amount of waste.

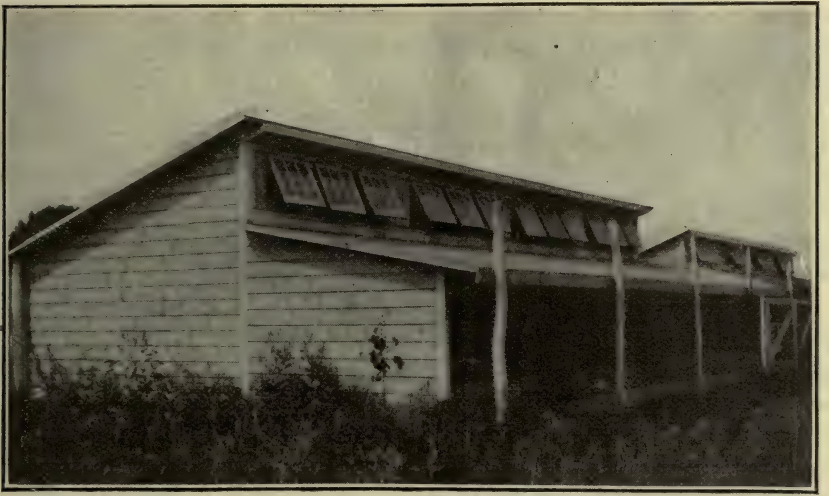


FIG. 11.—A semimonitor style of laying house.

CONSTRUCTING FLOORS.

Wooden floors are usually made of matched flooring and are generally doubled in cold climates to make them tight and warm, in which case the lower layer of boards is usually laid diagonally to strengthen the floor. Floors of one thickness give good satisfaction in the South and in growing houses. Three-quarter-inch mesh wire may be used under wooden or dirt floors to keep out rats. In making concrete or cement floors and walls, select Portland cement of known reputation, which should be kept in a dry place; use clear, coarse, sharp sand or gravel which does not contain over 5 per cent of clay or silt and crushed stone or gravel one-fourth to 2 inches in diameter. The gravel should be screened through a one-fourth-inch mesh wire screen and the coarse particles used as stone, while the material which passes through the screen is sifted through a 40-mesh wire screen in order to separate the sand, and any material which goes through the 40-mesh wire is thrown away. A mixing board with a smooth surface and a box for measuring the sand and gravel are necessary. Spread the sand on the board and add the cement; mix these thoroughly together; add three-fourths of the required amount of water, and then the gravel or stone; mix thoroughly and add water to the dry spots, making the mixture just wet enough to be jellylike. Thorough mixing is very essential, as the mortar should completely coat all particles of the mixture. Only enough water should be added so that when the concrete is tamped on laying the water will nicely flush the surface.

Good concrete mixtures may be made of 1 part (2 bags) cement, 2 parts sand, and 4 parts stone or gravel, which will take about 10 gallons of water in mixing; or 1 part (2 bags) of cement, 2½ parts of sand, and 5 parts of stone or gravel, which is mixed with about 12½ gallons of water. If natural gravel or sand is used without sifting, make the concrete of 1 part (2 bags) of cement and 4 parts of gravel, mixed with about 10 gallons of water, or of 1 part (2 bags) of cement and 6 parts of gravel with about 12½ gallons of water. A coating of clear cement or of 1 part cement and 1 part sand may be added to give a smooth finish to the floor. Most concrete or cement floors are damp and cold and, therefore, must be quite heavily covered with litter. A 4-inch foundation of cinders, broken stone, or gravel, which should be made firm by tamping, may be laid as a foundation for the cement floor, making the concrete 2½ to 3 inches thick. A layer of tarred building paper, which is lapped and cemented with tar at the seams, may be laid between the stone foundation and the concrete. This construction prevents moisture from coming through the earth and concrete, which makes the floor damp. Cement floors should always be built from 4 to 6 inches above the ground level to insure good water drainage. Concrete floors built on the earth are made from 3 to 4 inches thick, which is covered with a layer one-half to 1 inch thick of the finishing coat described above.

MATERIAL FOR COVERING WALLS.

The walls of most poultry houses in the North are built of sheathing and covered with specially prepared paper, siding, clapboards, or shingles. Sheathing paper is generally used on walls and roofs which are to be covered with shingles. A wall made of siding placed directly on the studs makes a satisfactory henhouse in the South. Another method of making a cheap, tight wall, used extensively in colony house construction, is to use boards 10 to 12 inches in width placed vertically with the cracks covered with battens 2 to 3 inches wide. Battens are usually 1 inch thick, and may be either nailed or screwed to the house. One-inch matched lumber is used extensively in poultry house construction, and makes a very satisfactory wall without any other covering than paint. Narrow lumber, 2½ to 6 inches wide, is usually used for this purpose, as wide boards are apt to shrink and warp, which results in cracks in the walls. The lowest board on the walls should extend into the ground below the sill to make a tight joint, which should also be made at the eaves where it may be secured either by cutting the rafters off even with the rear wall and covering this joint with good roofing paper, or by filling in the space between the rafters with boards or muslin curtains. A 4 or 6 inch board may be used on the rafters, allowing it to extend out 2 to 4 inches beyond the rear wall, or a double course of shingles may be laid and allowed to extend in this same manner. Sheathing should be laid so as to break joints in order to strengthen the building, while siding is usually laid working from the bottom upward. A shutter may be placed

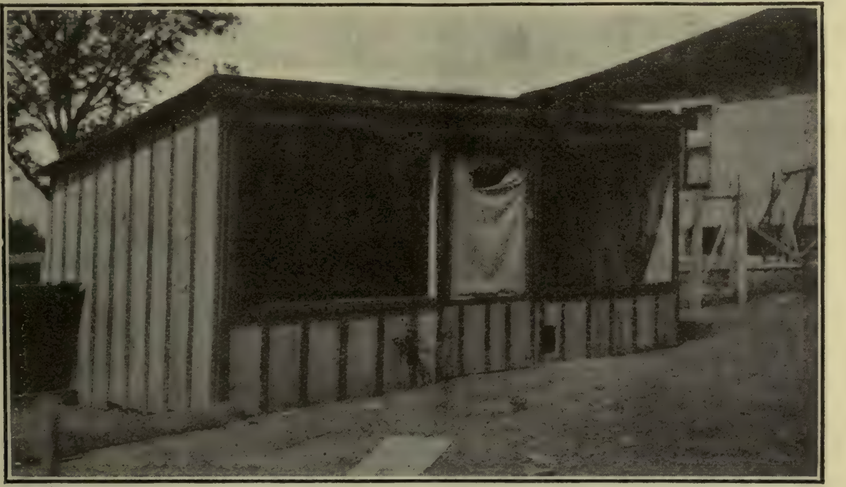


FIG. 12.—A laying house used in Georgia.

just under the eaves on the outside of the rear wall for summer ventilation. The essential point is to have a rear wall which is tight near the roosts to prevent drafts from striking the birds.

MAKING THE ROOF.

Specially prepared paper or shingles laid on sheathing may be used for covering the roof. Roofing papers are used very extensively for poultry houses at the present time, and in many places are replacing shingles. As a rule, the former are cheaper and easier to lay, while they can be laid on a much flatter roof than the latter. One or two-ply paper is usually used on the sides, and one, two, and three ply paper on the roofs, although this varies with different styles and grades of manufacture. This paper generally comes in rolls or squares, which cover 100 square feet, and contain directions and materials for use in laying. Paper may be used on roofs which have a slope or rise of 1 or more inches to the foot. Sheathing for paper roofs must be planed on one side and laid tightly to present a smooth surface for the roofing paper, while sheathing paper is often used between the sheathing and the roofing paper. Shingles may be laid from 4 to 5 inches to the weather on roofs which have one-third or more pitch, which is a rise of 8 or more inches to the foot, or one-third of the span of a gable roof. Cedar and cypress shingles are usually laid 5 to 6 inches to the weather on walls or on roofs with one-third pitch, but are not generally used on roofs which have a rise of less than 8 inches to the foot. One thousand shingles, or 4 bundles of cedar shingles, are the equivalent of 1,000 shingles 4 inches wide. In shingling, commence at the eaves or lowest edge by laying a double course, while the rest of the layers are of single courses. They are laid either to a chalk line, which is fastened at the right points at either edge of the roof and snapped to make a mark for the lower edge of the tier of shingles, or to a straight-edged stick. Each shingle is nailed with two either 5 or 6 penny nails, driven 7 to 8 inches from the butt, depending upon the lap, so that the heads of the nails will be covered by the next course. One thousand cedar shingles laid 4½ inches to the weather will cover about 125 square feet, depending on their size. Shingles may be laid on narrow sheathing 3 to 5 inches wide, or on common sheathing, which is spaced from 1 to 2 inches apart to allow the roof to dry out quickly, and they should break joints at least 1 inch and as much more as possible.

ESTIMATING THE AMOUNT OF MATERIAL REQUIRED IN BUILDING.

Lumber comes in even lengths usually 10, 12, 14, and 16 feet long. It is figured at so much per 1,000 feet board measure, which means the number of square feet which the material would cover if it were 1 inch thick. To compute board measure, divide the area of the cross section of the stick of lumber in inches by 12, and multiply by the length in feet. The accompanying table shows the number of feet board measure, in lumber from 6 to 16 feet long, with a cross section varying from 4 to 16 inches.

Table of board measure.

Length.	Area of cross section.					
	4 inches.	6 inches.	8 inches.	10 inches.	12 inches.	16 inches.
	Board measure.					
Feet.	*Ft. in.*	*Feet.*	*Ft. in.*	*Ft. in.*	*Feet.*	*Ft. in.*
6	2 0	3	4 0	5 0	6	8 0
8	2 8	4	5 4	6 8	8	10 8
10	3 4	5	6 8	8 5	10	13 4
12	4 0	6	8 0	10 0	12	16 0
14	4 8	7	9 4	11 8	14	18 8
16	5 4	8	10 8	13 4	16	21 4

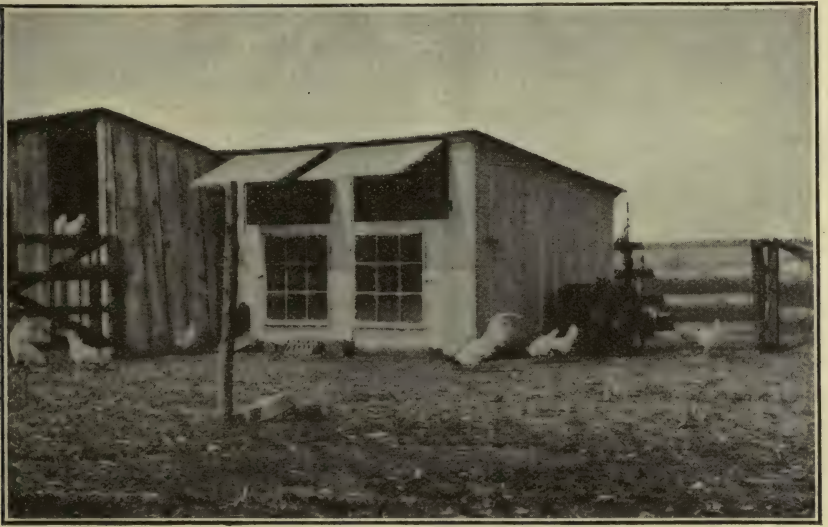


FIG. 13.—A colony house used in Texas.

Boards less than 1 inch thick are usually sold at so much per square foot, the price depending on the thickness of the lumber. Given the dimensions of a simple poultry building, one can work out a general bill of material required for its construction. A working plan of the building should be drawn to a convenient scale, usually one-fourth inch to the foot for poultry houses, showing the ground plan, the front elevation, and the end or a cross section of the house. The bill of material can be worked from this plan.

In estimating lumber allow for waste as follows: Common sheathing add one-tenth for waste, and one-fourth for matched flooring and all kinds of siding. Wire nails are generally preferred in construction as they are easier to use than cut nails, although the latter have greater binding power. Use 10 to 20 penny nails for framing; 8 to 10 penny for sheathing; 6 penny finish or casing nails for clapboarding, and 8 penny for siding. Four penny nails are 1½, 6 penny are 2, and 8 penny are 2½ inches long, etc. It takes about 8 pounds of 5 penny nails to 1,000 shingles; 18 pounds of 6 penny for 1,000 square feet, board measure, of beveled siding; 20 pounds of 8 penny or 25 pounds of 10 penny for 1,000 square feet of sheathing; 30 pounds of 8 penny for 1,000 square feet of flooring, and 15 pounds of 10 penny or 25 pounds of 20 penny for 1,000 feet of studding. Allow one bag of cement for about 13 square feet of concrete floor, adding one extra bag for every 10 running feet of foundation wall. This is estimated for a floor made of 3 inches of a 1–2½–5 mixture of concrete, covered with one-half inch of a finishing coat, containing equal parts of sand and cement.

The following tools will make a fair outfit for use in constructing simple poultry houses, or one may buy a tool chest and set of tools, which contains most of those mentioned herewith: Medium-sized hammer, hatchet, chisel, mallet, brace, set of bits, screw driver, plane, level, steel square, ripsaw (5 teeth to the inch), crosscut saw (8 to 10 teeth to the inch), compass saw, monkey wrench, oilstone, files, pair of pliers, chalk, and a 2-foot rule.

PAINT.

Painting adds greatly both to the appearance and service of all buildings and appliances. One may buy ready-mixed paints, or may purchase paste pigments and oil and mix them. All surfaces should be clean and dry before they are painted. Use a priming coat made of equal parts of paint and linseed oil and cover with one or more coats of paint, which should be thoroughly rubbed into the surface.

WHITEWASH.

Whitewash is the cheapest of all paints and may be used either for exterior or interior surfaces. It can be made by slaking about 10 pounds of quicklime in a pail with 2 gallons of water, covering the pail with cloth or burlap, and allowing it to slake for one hour. Water is then added to bring the whitewash to a consistency which may be applied readily. A weatherproof whitewash for exterior surfaces may be made as follows: (1) Slake 1 bushel of quicklime in 12 gallons of hot water, (2) dissolve 2 pounds of common salt and 1 pound of sulphate of zinc in 2 gallons of boiling water; pour (2) into (1), then add 2 gallons of skim milk and mix thoroughly. Whitewash is spread lightly over the surface with a broad brush.

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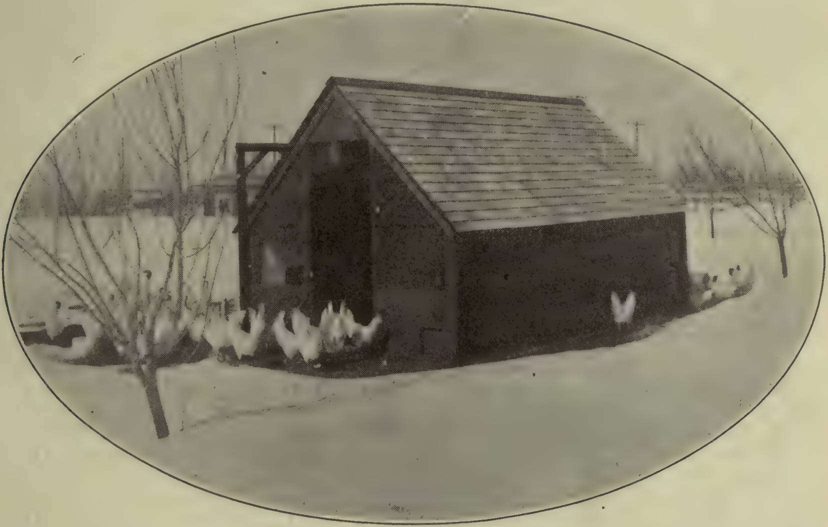
Utah Agricultural College

EXPERIMENT STATION

Circular No. 14



Housing Farm Poultry

BY

BYRON ALDER

Logan, Utah, November 1913

PRESS OF
THE F. W. GARDINER CO.
SALT LAKE

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Housing Farm Poultry

By BYRON ALDER

With the exception, perhaps, of actual starvation of the fowls themselves, there is no other factor in connection with the keeping of poultry that will affect egg production and good vigorous growth so decidedly as poor or improper methods of housing. This circular sets forth some of the essentials of a good house for Utah conditions, and offers plans of three houses in which an attempt has been made to include these essentials. The ideas and plans presented here do not represent any one person's original work. They are a compilation of the work done on this subject by those who have preceded the writer in charge of the work at this station, and suggestions that have come from a study of the types of houses recommended and in use in different parts of the country.

The Colony or the Stationary House.

There are two systems in common use throughout the country. The colony or free range system in which the fowls are kept in small flocks, housed in small movable houses, and the permanent yard system in which the fowls are more or less closely confined and the house is built in such a way, or of such material, that it is stationary. The colony system is admirably adapted to farm conditions where only from two to three hundred hens are to be kept. Where the fowls are kept in larger numbers than this considerable time is required to go from house to house to feed or gather the eggs. The advantages are, however, in being able to move the house from place to place about the farm or yard, thus giving the fowls fresh ground and pasture and utilizing space which at certain times could or would not be used for other purposes. The soil is less likely to become filthy and contaminated with disease. Where the soil on which these houses are kept is of a sandy or gravelly character, with good underdrainage, there is no need of floors in the colony houses, and the problems of cleaning and keeping the surroundings fresh and sweet are reduced to a minimum, since all that is necessary is to hitch a horse to the house and take it off a short distance to fresh ground, leaving all manure and filth behind. In winter the houses should be grouped more or less closely together in a convenient place and the soil banked up well around them before the ground is frozen too solid.

Plate I. Fig. 1.—Partial view of the Station Poultry Yards. Fig. 2.—Interior of Farm Poultry House shown in Plates IV and V.

In the permanent house larger flocks can be handled with less expense and trouble, because of many conveniences that may be provided for the general management of a large flock. Exceeding care should be exercised in cleaning up the yards and houses, in keeping the soil sweet and fresh by occasional cultivation, and in preventing the spread of contagious diseases.

Factors that Should be Considered.

Whether the colony or the stationary house is used, the problems to be considered in planning the house are very much the same. These may for convenience be divided into four groups.

The Health and Comfort of the Fowls.

Dryness.—The first essential of the house itself to insure health and vigor, is freedom from moisture. Since the house must be kept dry it must be located in a dry place. A gentle slope to the south with a porous soil and good air drainage is ideal. In many places it will not be possible to get the ideal, so that some provision must be made to keep the moisture out of the house. A good floor well up from the surface of the ground is about the best we can do. A concrete floor, under which is placed a six or eight inch layer of fine gravel or broken stone, will keep out the moisture and will be more easily cleaned and kept in a sanitary condition than the dirt floor. Many prefer the dirt floor, however, because of cost, and if six or eight inches of dirt are placed on top of the stone after a thin layer of cinders or other fine material covers the stone, it does fairly well and will usually be dry; but the dirt must be replaced occasionally by fresh soil and the cost of keeping it in condition will soon pay for the cement floor. In wet or damp surroundings evaporation is continually taking place, and evaporation is a cooling process, so that the temperature will be kept down. The hen's feet will be wet and muddy. This means fewer eggs and many dirty ones.

Ventilation.—Fresh air without draughts is the next important consideration. In the past warmth was the big object sought, and many houses were built with little or no ventilation provided for, or the openings that were provided caused draughts; now if we are not more careful in planning the house, the open front will be carried to the other extreme, as has been done already in some instances. No rule can be given as to just how much space should be left open in the front of the house, as that depends on the type of the house and somewhat on local conditions. One very important feature of all open front houses is that during the severe cold weather the other three sides of the house must be perfectly tight. To secure this these three sides should be constructed of matched lumber and lined either outside or inside, preferably the latter, with good heavy building paper. The double wall with a dead air-space is not necessary and is undesirable. It offers protection and a breeding place for mice, rats, mites, etc., and adds considerably to the expense of the building. In the hottest part of the summer an opening may be provided in one of the other sides, providing it is not located so that a draught would strike the fowls while on the perches.

While reasonably cold, pure fresh air is to be preferred to warm impure air, yet it should not be forgotten that it is the purity of the air and not the low temperature that is desired. The more surface there is exposed in the walls and roof of a house the greater will be the loss of heat, other things being equal. For this reason it is not desirable to extend the walls higher than is necessary to allow sufficient room in the house for the attendant to move about freely without continually bumping his head. The greatest vigor and production cannot be secured if the fowls are required to breathe impure or very cold air. Early spring condition, when we have our highest egg production, should be the aim in this regard both winter and summer. Plenty of fresh air with a moderate temperature, and good, clean, nutritive food brings high production in eggs and meat.

Sunlight.—This third essential for healthful, vigorous stock must be provided for in a good chicken house. For this reason the open front has become very popular and the house should always face to the south. The opening should not be too low or the snow and rain will drift in and dampen the litter, and the fowls should be protected from the cold wind while at work on the floor. Two to three feet from the ground to the bottom of the opening will give this protection and will not shade much of the floor space. It must extend as high as possible so that the sun will go to the back of the pen. The direct rays of the sun not only make the house warmer but keep the interior dry and are the best of disinfectants and germicides that we know. They aid materially in preventing disease. Very much glass space is undesirable, not alone because of the additional expense and breakage, but it is estimated that glass allows about four times as much heat to escape from the building as the ordinary board wall. In this respect it is not much better than the muslin curtain, and on sunny days the curtain may be raised to allow the sun's rays to enter without reflection in any direction.

Convenience.

It seems to be more or less a fault in human nature that those tasks are more often neglected that are a little out of our way, or are a little difficult to get at. There is no animal around the yard that responds more quickly to kind, sympathetic and regular treatment than does the hen. The poultry house should not be located, as it too often is, after all other buildings, sheds and yards are planned, and then find that there is room out behind the barn or some other out-of-the-way place for the chicken house. Much of the work in caring for the fowls is done by the women or is not done at all, and therefore, the house and yards should be readily accessible to them. All gates, doors and other fixtures should be made as simple as possible, yet securely fastened and easily operated. There should be plenty of room to get inside the building. The nests, feed hoppers, etc., should be easily reached, so that cleaning and refilling is made as easy as possible. It is sometimes advisable to arrange the nests so that the eggs may be gathered without going into the house.

Protection from Vermin.

The house should not be located close to the grainery, barn or other buildings where grain is stored that afford breeding places for mice and rats, to prey upon the fowls. The building should be made as tight as possible to exclude all such enemies. All nests, perches, etc., and the interior surface of the house itself should be as smooth and free from cracks and unnecessary corners as possible. The internal fixtures should be solid, yet easily taken out to clean and disinfect.

Cost.

Many who have gone into the business of poultry raising have failed because of the lack of consideration of this factor in connection with the poultry houses. It is necessary of course to make a building as permanent and substantial as the local conditions demand, yet buildings of this nature need not be elaborate in construction or of expensive materials. Except, perhaps, in special cases, the cost of the house should not exceed one dollar and a quarter for each fowl that it will accommodate when complete. This is not given as a rule, but to indicate what we should expect in this regard. To illustrate further, the total cost of the colony house shown in Figures 3 and 4 including material and labor should not exceed thirty dollars, and it will accommodate under usual conditions about fifty hens of the smaller and forty of the larger breeds, making a cost in the one case of sixty cents per hen, and in the other seventy-five cents per hen.

By following the ideas suggested above, a number of houses could be planned that would no doubt be entirely satisfactory. On the following pages are given detailed plans, slightly modified, of three houses that have been tried at the Utah Experiment Station and different parts of the State, and proved to be eminently satisfactory.

It is not necessary in any case to follow strictly all the details given in all respects. An attempt has been made to furnish these definite instructions and details of plan to those who are looking for just such specific information. A general discussion of the construction and a bill of the material required is given for each of the different plans.

The Utah Station Colony House.

This house has been used for several years at the Utah Station poultry yards, also at two or three other places in the State, and is found to be very satisfactory for Utah conditions. Because of the small size and substantial construction it can be readily moved about from place to place on the 4 by 4 skids, which also serve as a foundation for the house. This house will accommodate from 40 to 50 hens, and is highly recommended for use where flocks of two to three hundred or less are kept on the farm, or for a special breeding or brooding house on large poultry farms. The front should be left entirely open as shown, with no curtain of any kind, except in some of the higher valleys of the State, where it may be advisable during the

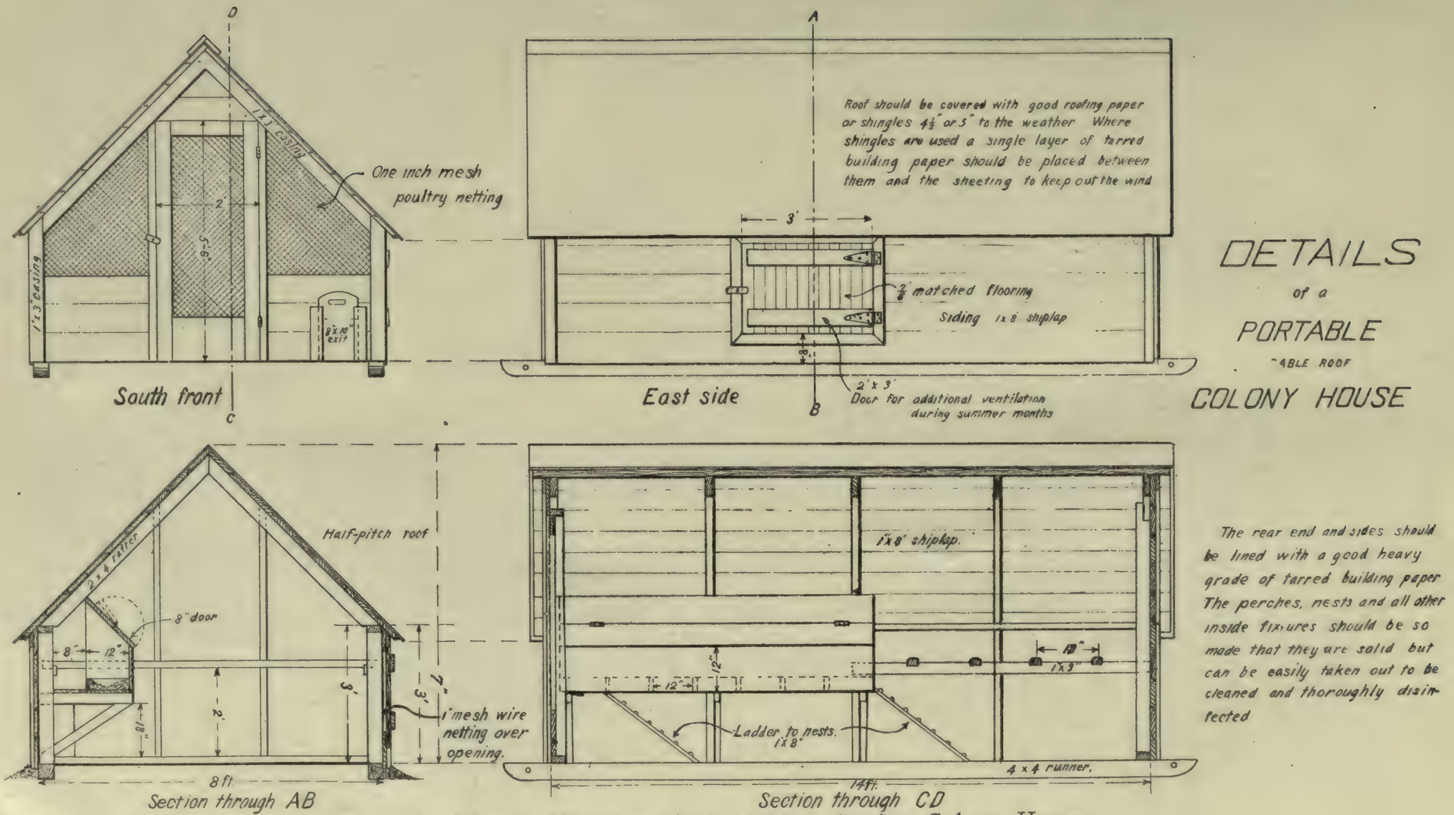

D
A
One inch mesh poultry netting
1"x3" casing
1 x 3 casing
2'
5'-6"
8"x10" exit
South front
C
Roof should be covered with good roofing paper or shingles 4½" or 5" to the weather Where shingles are used a single layer of tarred building paper should be placed between them and the sheeting to keep out the wind
3'
⅞" matched flooring
Siding 1x8 shiplap
8"
2'x 3' Door for additional ventilation during summer months
East side
B
DETAILS
of a
PORTABLE
GABLE ROOF
COLONY HOUSE
Half-pitch roof
2 x 4 rafter
8" door
8"
12"
3'
2'
18"
7'
3'
1" mesh wire netting over opening.
8 ft.
Section through AB
1"x8" shiplap.
12"
12"
18"
1"x3"
Ladder to nests. 1"x8"
4 x 4 runner.
14 ft.
Section through CD
The rear end and sides should be lined with a good heavy grade of tarred building paper The perches, nests and all other inside fixtures should be so made that they are solid but can be easily taken out to be cleaned and thoroughly disinfected

Plate II. Fig. 3.—Working plans of Utah Station Colony House.

coldest part of the year to hang a curtain to the rafter just in front of the perches, and down to within about a foot of the floor.

Material.

The lumber used need not be of the best grade. Select common shiplap, or No. 2 rustic is good enough, providing the sides and rear end are lined with good two-ply building paper or tarred felt. This lining of paper would be necessary with the best grade of lumber, because of the openings at the joints. Where shingles are used a single layer of paper should be placed between the shingles and the sheathing to keep out the wind. The sheathing should be placed close together to make the building warmer. A good grade of prepared roofing may be used, and is a little cheaper than shingles, but not so durable.

Construction.

See Fig. 3. Round off one side at each end of the skids and drill a ¾ inch hole about six inches from the end to run a clevis pin through to hitch a chain or spreader on when moving the house. Cut one piece of 2x4x16 in the center and nail these pieces firmly, one foot from the ends of the skids, for the front and rear plate. On the under side of these at each end nail firmly a short piece of 1x3 butting close up against the skids to prevent them from pulling together. The rest of the frame work is all 2x4 and should be well fitted and securely nailed. The point of the rafter should not project beyond the outer edge of the wall plate. When the frame is finished, tack the building paper onto the outside of the studding, then nail the siding on so as to hold the paper in place. Where joints occur in the paper be sure that they overlap well, then tack a thin board strip or cleat over this joint from the inside of the house. This paper gives a smooth clean surface to the inside and offers very little protection and few breeding places for mites, and is the only sure way to prevent draughts. The siding may be nailed on first and the paper put on the outside of this as shown in Fig. 4, but the former method is generally to be preferred.

The opening for the door in the side may be cut out after the siding is nailed on. Extreme care should be taken to fit the door well in this opening, so that no cracks are left to cause a draught in the house in winter. The door should be kept closed during the coldest part of the year.

The boards at the bottom in front should not extend up more than two feet and are placed there only to keep the snow and rain from drifting in. Two pieces of 1x6 should be cut to fit between the runners at the front and rear, but should be left so as to be easily taken out when the house is to be moved onto a new piece of ground. No floor is provided in this house. It, therefore, cannot be used except on dry well drained soil. A wet damp place should never be selected for a hen house, unless no other is available, then it will be necessary to provide a floor to keep the interior dry.

The cut on the front page shows this house in use in winter. There is usually a breeze from the canyon at this place during the winter as indicated by the drifted snow and the trees. This house gave excellent results except during the summer, and it was found advisable to add the side door for additional summer ventilation.

The perches should fit in notches cut in the 1x4, but should not be nailed nor fitted tight. The two top edges should be rounded and the entire piece made as smooth as possible. A good heavy coat of paint would make the perches easily cleaned and cover rough spots or cracks that would otherwise afford breeding places for mites. The nests should be made of good pine, free from rough knots or cracks and not securely fastened to the bracket on which it rests. It must be easy to take out to clean and disinfect.

A good coat of paint when the house is new adds greatly to the appearance and is a great preservative for the lumber.

Bill of Material for Utah Colony House.

Size of house, 8 ft. by 14 ft., 3 ft. to eves and 7 ft. to peak.

2 pieces 4x4—16 ft. long for runners.
6 pieces 2x4—12 ft. long for rafters.
6 pieces 2x4—16 ft. long for studding.
2 pieces 2x4—14 ft. long for wall plates.
10 pieces 1x8—14 ft. long shiplap for sides.
8 pieces 1x3—12 ft. long for casing over corners, doors and next to roof.
1 piece 1x4—12 ft. long for casing over corners.
2 pieces 1x12—16 ft. long, and

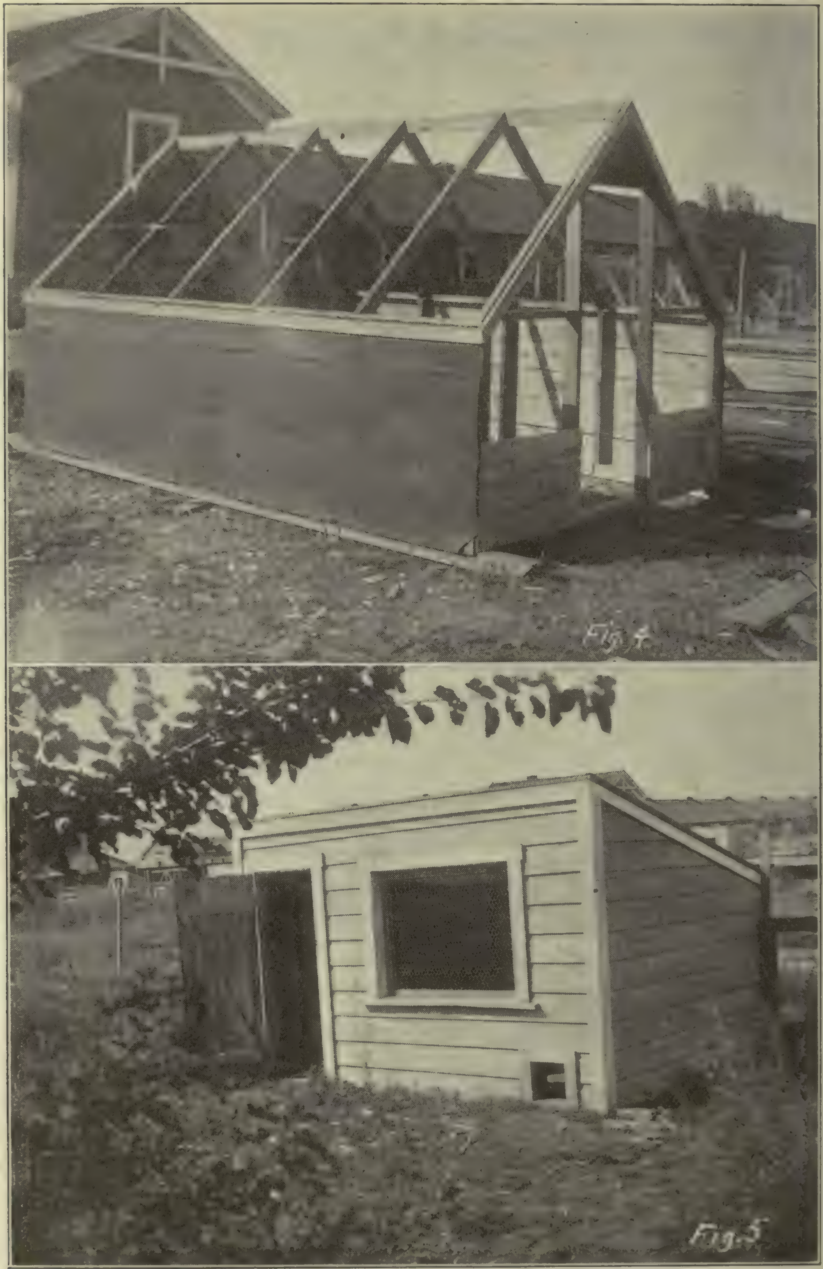


Plate III. Fig. 4.—Frame work of Utah Station Colony House.
Fig. 5.—Shed roof Colony House.

1 piece 1x4—16 ft. long No. 1 pine for nests.

1 piece 2x6—16 ft. long, ripped through center, for perches.

1 piece 1x4—16 ft. long to support perches.

1 piece 1x6—16 ft. long to cover opening between skids.

25 pieces 1x8—16 ft. long shiplap for ends and roof.

1 rod of 2 ft. 1 in. mesh wire netting.

1 piece of 1x8x16 ripped to 4 in. and 3½ in. for saddle.

1 roll of good building paper.

Shingles 5 in. to weather, 7 bunches, 1750 shingles.

Five lbs. No. 4d nails; 8 lbs. No. 8d nails; 6 lbs. No. 10d nails.

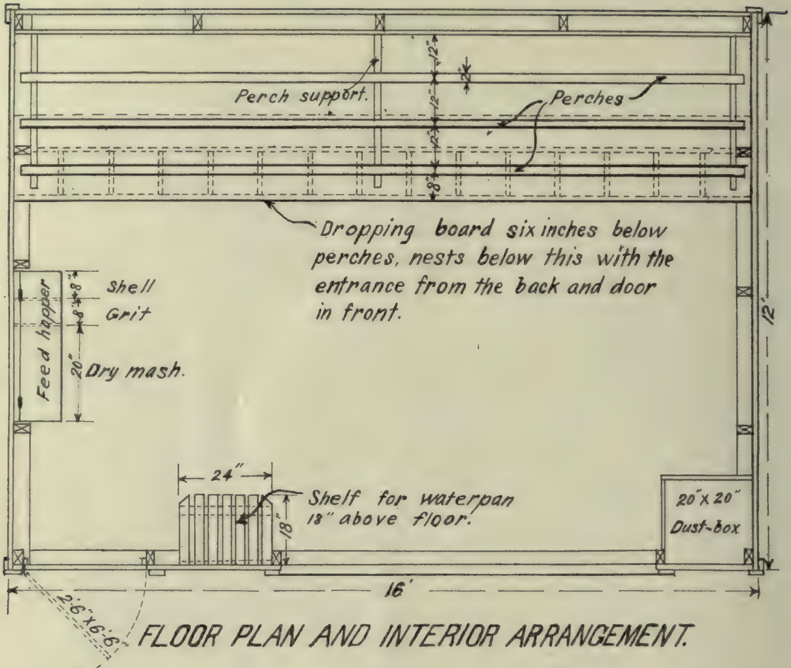
Estimated cost, labor and material, $30.00.

Shed Roof Colony House.

A cut of this house is shown in Fig. 5. It is ten feet long, eight feet deep, six and one-half feet high in front, and four and one-half feet high at the back. The opening in the front is three by four feet and has a curtain on a hinged frame which swings up and fastens to the roof. The house is built on 4x4 skids and is lined with heavy paper. A house of this size is large enough for twenty to twenty-five hens. This house is a little better for small flocks in a city lot than the one shown in Fig. 3, and is used at present more extensively. It is not as warm for winter use, but gives a little better circulation of air to the fowls in summer than the gable roof house described above. The perches and a dropping board are placed along the back and the nests are placed under the dropping board.

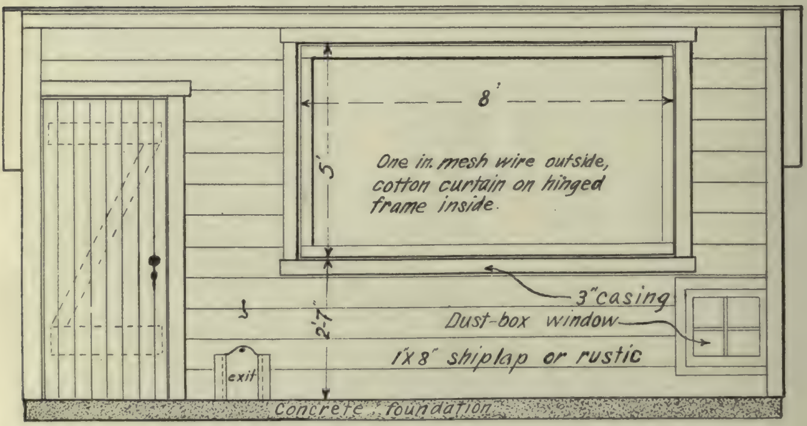
Farm Poultry House.

In Figs. 6 and 7, is given the plan of one section of this house. Other sections the same as that shown may be added at either end as the increase in the size of the flock makes this addition necessary. The plan shows a concrete floor which is advisable under most conditions, and is necessary where this house is located in a damp place. As a rule a cement floor is more desirable than a wooden floor, because it can be kept more sanitary, offers little or no protection to mites or other vermin, and when once put in is permanent and needs no repair. In case a cement floor is used it should be made


Perch support.
Perches
12"
2"
12"
12"
8"
Dropping board six inches below perches, nests below this with the entrance from the back and door in front.
Feed hopper
8"
8"
20"
Shell
Grit
Dry mash.
24"
18"
Shelf for waterpan 18" above floor.
20" x 20" Dust-box
12'
16'
2'6"x6'6"

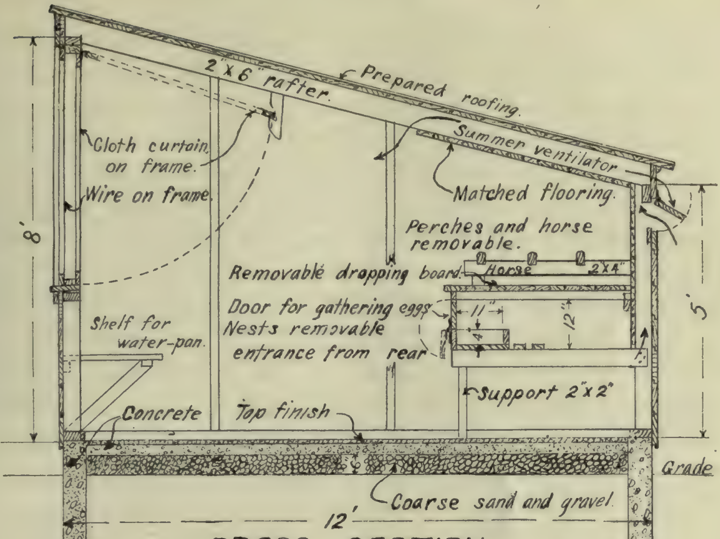
FLOOR PLAN AND INTERIOR ARRANGEMENT.

PERMANENT LAYING HOUSE

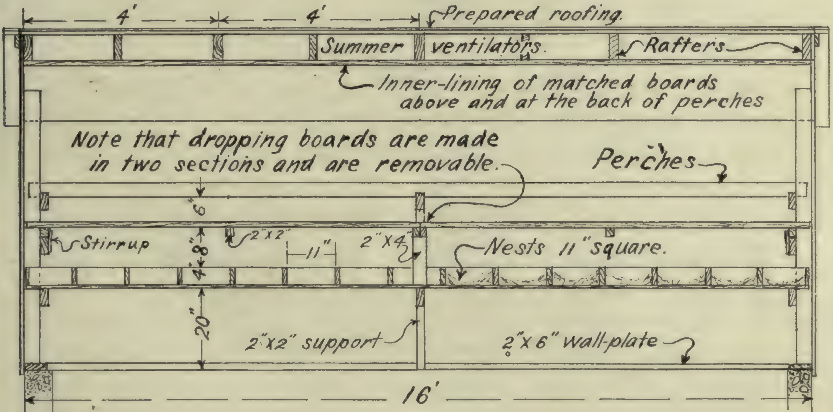


FRONT ELEVATION.

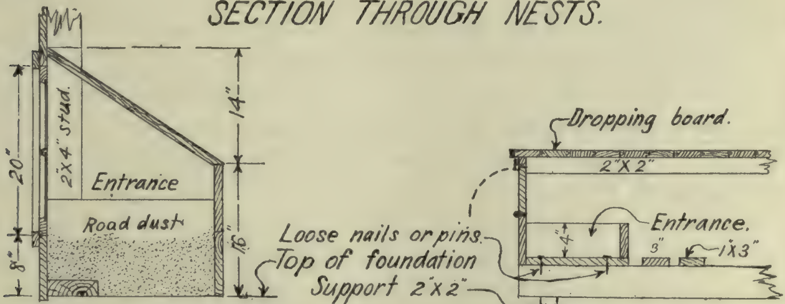
Plate IV. Fig. 6.—Plan of Farm Poultry House.



CROSS SECTION.


4'
4'
Prepared roofing.
Summer ventilators.
Rafters
Inner-lining of matched boards above and at the back of perches
Note that dropping boards are made in two sections and are removable.
Perches
6"
Stirrup
2"x2"
11"
2"x4"
Nests 11" square.
4-8"
20"
2"x2" support
2"x6" wall-plate
16'

SECTION THROUGH NESTS.



DETAILS of DUST-BOX DETAILS of NESTS

Plate V. Fig. 7.—Details of construction of Farm Poultry House.

reasonably smooth and level with the top of the foundation so as to make cleaning easy. A cement floor should never be left bare, but should always be covered with at least three inches of sand and with from six to ten inches of straw. Because of the little wear there would be on the floor it is not necessary to make the concrete very strong, perhaps 1:3:6 would be good enough. On a well drained sandy or gravelly soil it would not be necessary to put in a floor of any kind. Under these conditions a sand or dirt floor is cheap and advisable. The level of such a floor should be higher than the ground outside. Hens like a dirt floor if it is kept dry, as it gives them a natural dust wallow, but must be frequently replaced to keep it in a clean, sanitary condition. A concrete floor would make the house easier to clean and in the long run might save considerable labor and expense.

Under all conditions it would be necessary to have a good foundation extending at least six inches above the surface of the ground, and down far enough so that the frost could not get under.

The house as shown is 12x16 ft. and will accommodate eighty or ninety hens. Perhaps in special cases it would be advisable to increase the depth to fourteen or perhaps sixteen feet.

Construction.

The siding should be a good grade of shiplap or rustic and must be lined with a good grade of building paper. Many old houses were built with rough boards running up and down and the cracks covered with battens. This is very undesirable in a place where the winters are as severe as in Utah. The battens work loose and the fowls are subjected to draughts from all sides. The double wall is sometimes made by nailing boards on both the inside and outside of the studding; this is not necessary and is undesirable as already explained. The only place that a double wall is necessary is above and behind the perches. This is to protect the fowls from draught when the rear ventilator is open.

It would not be advisable to use shingles on a roof as flat as this one. Where prepared roofing, either felt or paper, is used, it is not necessary to cover the roof first with building paper. Under no condition should a poultry house be covered with boards and battens.

The dropping board and nests are made in two sections and held in place by means of a stirrup or hook. They should be made just as light, yet substantial, as possible, must be solid, not shaky, but easily taken out to clean and disinfect. Everything in the house except the dust box and feed hoppers should be at least 18 inches from the floor. This allows considerable room for the fowls to work. There should be but one entrance to the dust box, so as to keep as much dust as possible out of the house. It would be best to have the top of this box hinged or removable, so that it may be taken off to clean and refill. See Fig. 7.

The door is made of matched flooring, the same as the drop board, and is provided with a good lock.

The frames for the wire and muslin should be made of good material, 1¼ by 3 inches, with at least one cross brace. The frame on which the wire is nailed need not be hinged, but made so that it can be taken out when necessary.

Bill of Material.

23 pieces 1x8x12 shiplap for ends.
17 pieces 1x8x16 shiplap for rear and front.
23 pieces 1x8x18 shiplap for roof.
2 pieces 2x6x12 wallplate.
2 pieces 2x6x16 wallplate.
9 pieces 2x6x14 rafters.
11 pieces 2x4x16 studding.
44 pieces ¾ in. x 16 ft. No. 2 flooring, for door, drop boards and inner wall over perches.
2 pieces 2x6x16, ripped through center, for perches.
3 pieces 2x2x16 for drop boards and nest support.
11 pieces 1x3x16 for casings on corners around door and window and under roof.
2 pieces 1x6x16 doors for nests and ventilator in rear.
2 pieces 1x3x16 for platform at back of nests.
2 pieces 1x4x16 nests.
1 piece 1x6x16 nest front.
1 piece 1x12x16 nest bottom.
4 pieces 1x6x16 frame, window and door.
1 piece 1x8x16 dust box.
1 window sash, 20x20 in., 4 glass.

3 pieces 1¼x3x16 frames for curtain and wire over front of opening.

2 rolls No. 1 heavy prepared roofing, 220 sq. ft.

350 sq. ft. two-ply tarred building paper.

For foundation—

68 cu. ft. concrete, mixture 1:2½:5.

14 bags of cement.

33 cu. ft. sand.

66 cu. ft. stone or gravel.

Estimated cost of material, $60.00.

For floor—

83 cu. ft. coarse gravel or stone for first 6-inch layer.

55 cu. ft. of concrete, mixture 1:3:6.

10 bags of cement.

15 cu. ft. sand.

30 cu. ft. stone or gravel.

Additional cost for concrete floor, $20.00.

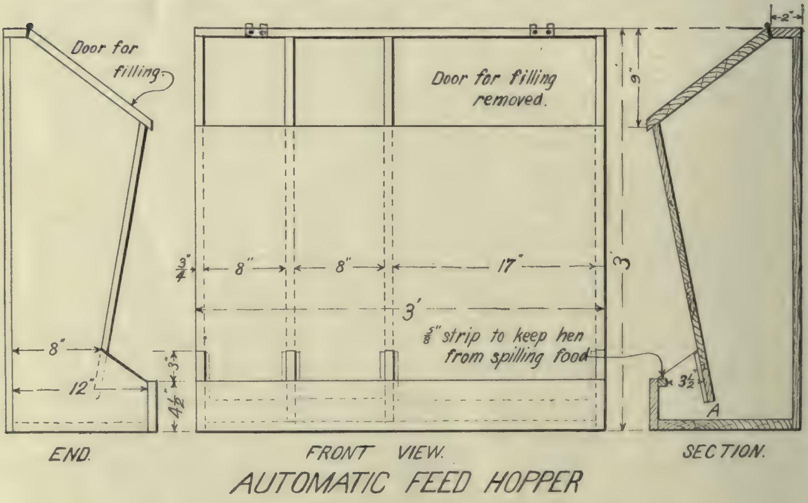


Fig. 8.—Dry Mash Feed Hopper.

Feed Hopper.

Fig. 8 is the plan of a good feed hopper, especially adapted for dry mash, grit, charcoal, etc., and may be used for whole grains where desired. The opening at A, where the feed passes out so that the fowls can get it, should be about ⅜ inch for wheat or oats; ¾ inch for charcoal, oyster shell or grit, and about 1 to 1½ inches for dry mash, if composed largely of bran. The back should be placed squarely against the wall. The top is slanted at about forty-five degrees, so that the fowls cannot roost on it.

4/200

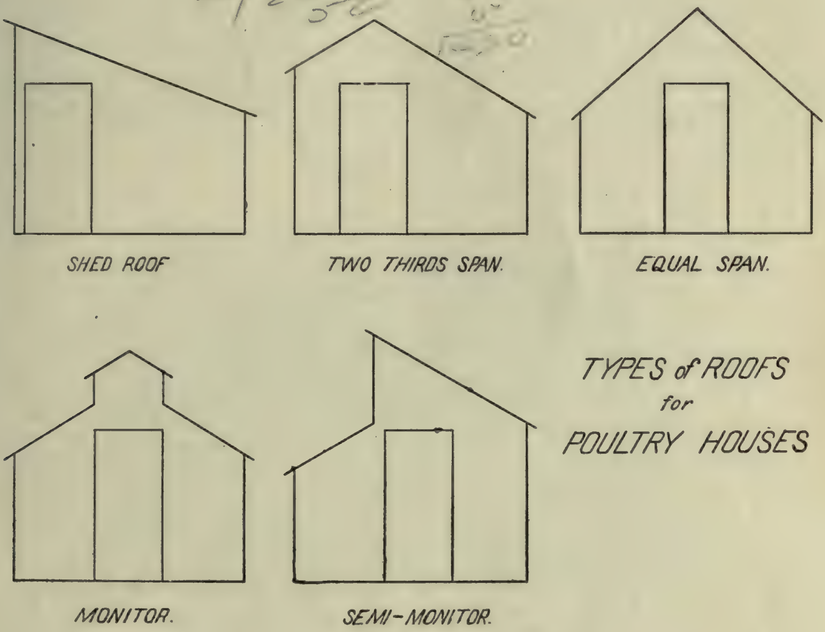


Fig. 9.—Types of Poultry Houses.

Types of Roofs for Poultry Houses.

In Fig. 9 is shown the different types of roofs for poultry houses. The shed roof is one most commonly used. It carries all of the water to the back, leaving the south front dry and allows more sunshine directly into the house. The two thirds span is a modification of the shed roof and is especially used on houses more than fourteen feet deep. The shed roof for deep houses give too high a front and require too heavy material for the roof to hold up the heavy snow that falls in most parts of the State.

The equal span roof is especially adapted for colony houses or comparatively small farm houses. A house with this roof can be built low yet roomy inside and will thus be warm in winter, as the air when heated by the fowl's body does not readily pass up and out of the house.

The semi-monitor is the tall narrow shed roof with a small shed roof, or lean-to, built in front for scratching shed. It cannot be used for long houses because all material going in or out in cleaning must come through the end, as the sides are too low to permit a door to be placed in them. The monitor roof is too complicated in construction for poultry houses. It is too high and allows too much heat to escape, and is, therefore, little used under climatic conditions similar to those found in Utah.

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THE UNIVERSITY OF WISCONSIN
AGRICULTURAL EXPERIMENT STATION

Poultry Building at Wisconsin College of Agriculture

POULTRY HOUSE CONSTRUCTION

BY

J. G. HALPIN AND C. A. OCOCK

MADISON, WISCONSIN

The University of Wisconsin
Agricultural Experiment Station

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POULTRY HOUSE CONSTRUCTION

J. G. HALPIN and C. A. OCOCK

One of the most essential things in poultry keeping, is to have a suitable house which will protect the fowls from inclement weather and from their natural enemies. It is not the purpose of this bulletin to show each one exactly how to build a poultry house, but some of the elementary principles of poultry house construction are discussed and a few working plans are given, which it is hoped can be modified to suit different conditions on different farms. It is well understood that no two farms will present exactly the same conditions for instance, one farmer will desire to keep one hundred hens while another may want many more or less. Then again some farms will present one kind of soil, whereas on other farms the character of the soil and drainage are entirely different. Some farmers will desire a house which presents an attractive appearance whereas on other farms poultry houses will be so located that they are not conspicuous, and hence the matter of appearance is of little concern.

It must be remembered that from the standpoint of the hen, appearance makes very little difference, but the house must be so built and so arranged that it will be a comfortable place for the hens to live; otherwise they will not thrive and production will not be satisfactory. On many farms the hens are not provided with a house constructed especially for them but are housed in an old building originally made for some other purpose. As a rule this sort of a house is not economical for, unless it is constructed especially for hens, it will seldom be found possible to reconstruct it in such a way as to make economical production possible.

POULTRY HOUSE SITE

Poultry houses should be located where it is dry and well drained. If the ground is not naturally dry, it should be ditched and drained artificially, for poultry will not thrive in a house when the floor is constantly wet. A damp location means a damp poultry house all the way through and the result is that the fowls are affected with many troublesome diseases. Damp ground that is likely to remain muddy around the house is not satisfactory because the hens' feet become soiled and, as a consequence, the eggs and nests become dirty, and dirty eggs are unattractive on the market. If cleaned, a large amount of labor is necessary and with the best of care, cleaned eggs never look so well as eggs that have never been soiled. When hens run at large on wet ground, the litter on the floor of the house soon becomes dirty and wet, thus making a very unsatisfactory place for feeding. The ground out-of-doors is also unsatisfactory for feeding as wet ground soon becomes filthy and the filth sticks to the feed, making it impossible for the hens to pick it up without consuming more or less filth. Ground which is naturally wet is cold in the spring. It is also slower to become aerated and holds filth on the surface much longer than dry ground.

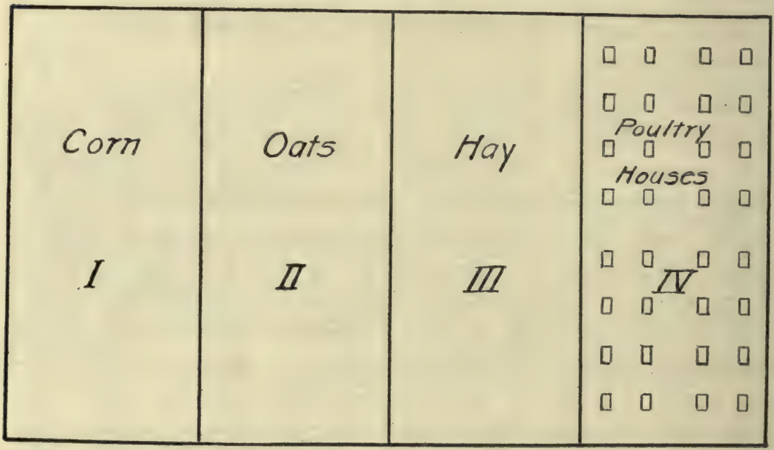


Figure 1.—A system of rotation is possible with portable colony houses. The houses can be moved each year to a different field

Houses should be placed so that they will not be subject to violent winds; yet, good air and drainage are essential. A house should never be placed in a low, damp spot where early fall frosts are likely to occur. These places are always cold and unhealthy for fowls.

Build the house on ground that slopes to the south if possible. If this can not be done, always face the house toward the south so as to get the sun's rays throughout the day in winter to keep it bright inside. Where it is necessary to build a house in a windy place, trees can often be planted to break the wind. Small shrubs are also a great help and can be planted in such a way that they afford shelter to the house during the fall and spring when the winds are violent. Hens enjoy lying in the sun especially during the windy days after the leaves fall from the trees. The orchard can often be chosen as the site for the hen house and the hens allowed to run under the trees throughout the year.

Poultry houses should be convenient to other buildings, and yet, not so close that the hens constantly infest the other buildings. If the poultry house is too close to the barns, the hens are likely to get in the habit of roosting in the barn, cow stable, tool shed, etc.

COLONY HOUSE SYSTEM

The colony house system consists of having one flock or one colony in one building. Colony houses are of two types, the portable and non-portable. The portable type of colony house has many advantages, especially for growing young stock. The usual method is to nail them on runners and then have a team draw them from place to place as wished. This type of house saves much feed which has been wasted in the fields. You may draw the house into the grain field after the crop has been harvested, and then, after the oats is cut, the house and chickens can be moved into the oat field, etc. In this way, stock is always kept on clean ground and gets more insects than would be possible when kept around the farm buildings. In some years, especially when grasshoppers are abundant, poultry out in the field will pick their living and at the same time rid the farm of troublesome insects.

With this system of housing there is, of course, much more danger from thieves. In some localities, it would be found necessary to protect the windows and doors with iron bars while in other localities stock would be perfectly safe. A good watch

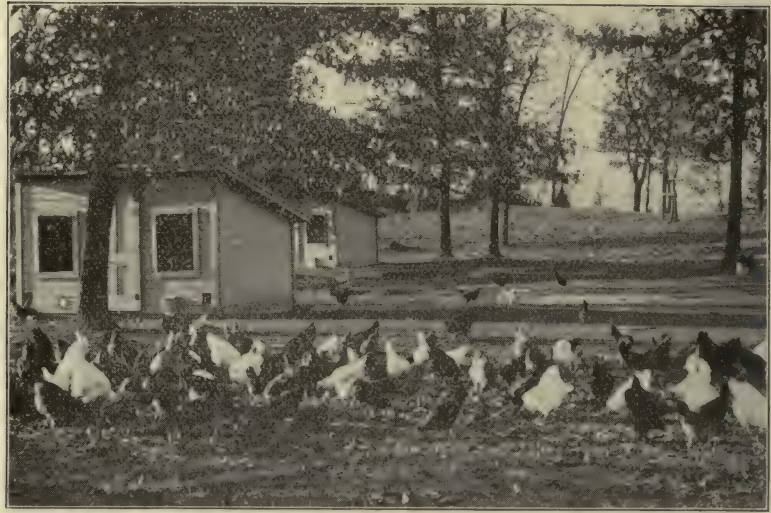


Figure 2.—Portable Colony Houses and Flocks on the Range.

dog can often be used. On some of the larger farms where poultry is kept quite extensively, it is found possible to keep the chickens in portable colony houses throughout their lives. The young stock is started while the houses are near the farm buildings so that they can be protected from their enemies and cared for without a great deal of trouble. As they get older they can be moved farther from the buildings out into the field. Toward fall the houses are drawn in near the farm buildings and placed close together so that they can be cared for readily throughout the winter.

A small house of the non-portable type is most frequently

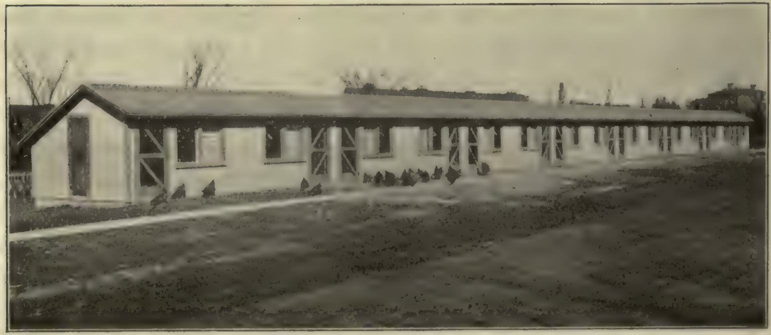


Figure 3.—Long Poultry House at Wisconsin College of Agriculture.

used on the general farm. Its principle disadvantage appears in fall when with the chickens all in one colony, it is necessary to put the hens and pullets together, with the result that the hens, being accustomed to the house, abuse the pullets when they first come in from the range. With this type of house, there is no chance to select the best laying and most vigorous females. This plan makes it necessary to keep enough males to fertilize the eggs of the entire flock. Market eggs are not as good quality when fertilized for, fertilized eggs often start to grow before they reach the consumer. Farmers seem to be afraid of allowing infertile eggs because they feel that some hens will steal their nests and not be able to hatch. There is little advantage in hatching chicks from stolen nests for the hens that steal their nests are generally hens that did not begin laying until late in the spring and very often they are the poorest hens in the flock and do not produce chickens worth the raising.

THE LONG HOUSE SYSTEM

Long houses with or without cross partitions, are used on many large poultry farms. This type has the advantage of being less expensive to build, and they require less labor to care for the fowls as the attendant goes from one pen to another more quickly than he can go from one detached house to another. Long houses have the ground more closely stocked and there is much less natural feed such as insects, green grass, etc. As large numbers are kept closely together, the tendency to disease is greater. The grounds and buildings need more careful watching to keep them sanitary. Much fertilizer is wasted as the ground next to the house cannot be utilized to advantage for growing crops. Where large numbers are kept together, the tendency to form bad habits such as egg eating, etc., is much more pronounced. The long house with partitions across it is usually to be preferred to the long house without partitions. With several partitions in a house one can divide the hens to advantage and treat them much more as colonies of chickens are treated.

With this type of house one can resort to several methods of yarding. A good method is shown in Figure 4. In this diagram each pen has an individual yard on the south where the stock is allowed to run in fall and early spring. The north side is left as an open field in which the hens run during summer after the breeding season, and, being accustomed to their pens, the majority of them return to their own places without trouble. While they are occupying the north yard, the south yard is cultivated and sown to a crop of buckwheat and rye to sweeten the ground and furnish fall and spring pasture. This sowing would be done on most farms late in June or early in July. The space immediately north of the house is more likely to become contaminated. It is, therefore, desirable to grow a crop of some kind on this each year. Corn or sunflowers are grown on many farms as the corn is planted early and attains considerable size before the hens are turned on. The result is that the hens secure shade in the corn field and get an abundance of green stuff from the alfalfa or clover at the back of the yard. This yard at the back may be mowed and a good crop of hay secured. Just what can be accomplished, of course, depends to a great extent upon the character of the soil found in the yard. The principal thing is to keep it constantly cultivated so as to get rid of filth as much as possible.

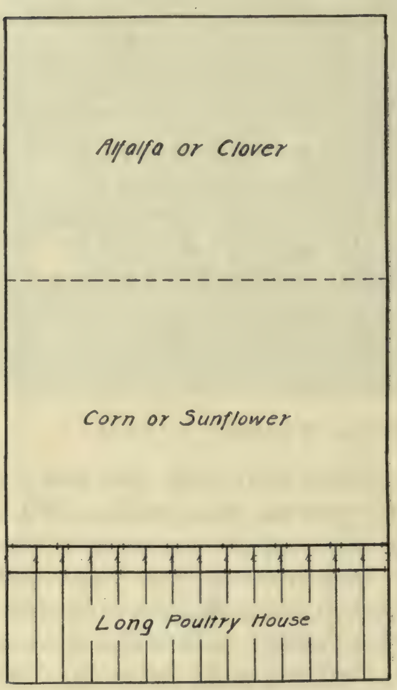


Figure 4.—Long Poultry House With Yards in Front and Open Field Behind.

The continuous house without partitions should be yarded on both north and south. This type of house, of course, is less expensive as there are no inside fences in the yard. The principal disadvantage of this system is that the hens crowd to the end of the house at feeding time unless hopper feeding is used almost exclusively. Expert care is needed to keep such a large number of hens from acquiring bad habits. An expert can care for a large flock, but an amateur might better care for fewer hens and give them more individual attention.

General farmers who keep only a few chickens, as well as large poultry plant owners can use the small portable houses for growing chicks. They are especially good for pullets which develop much better on free range than under closely confined conditions. A system of portable houses is used in many parts of the country where poultry is kept extensively. With a portable house system, there is no excuse for the ground becoming contaminated. The houses are moved from one field to another before the ground becomes filthy and the fertilizer is saved for growing crops. From the standpoint of fertility, this is by far the most economical system. The general farm which keeps only a few chickens should have either two small houses, one for pullets and the other for hens in the fall, or else one house with a division in it. In this way it is possible to make up the breeding pens from the best hens and pullets in the spring, and then later to allow all to run together, if advisable. In either case it is far better to fence in the hens that are not kept for breeding purposes giving the breeding flock free range of the farm. No matter what system is used, it is always best to encourage the hens to range near their house and away from the other farm buildings. To do this, keep the house clean. It often pays to store some feed there so that the hens expect to be fed from the house and not from the barn.

A common mistake is that of feeding the fowls from the back porch, in this way teaching them to come to the house where they are pests. All the kitchen scraps that are to be utilized for poultry feed should be placed in a pail, carried to the poultry house and fed in a clean place or in clean troughs near the house. Another common mistake is confining the hens in a small yard, when frequently a little more fence could be used around the garden and house and the hens kept where desired, yet allowed abundant range. At times a rather closely woven field fence could be erected around the orchard and thus give the hens abundant range without much additional expense. A low fence will confine hens when allowed a good sized range whereas a high fence is necessary where the range is small.

Poultry houses usually have one of two great faults. They are constructed either with an all glass front or with practically no glass. The house which contains a glass front becomes extremely hot during the day in winter and extremely cold at night; whereas a house with little or no glass is damp and dreary, and the hens almost never thrive in such a place. A poultry house must be light so that the hens can readily see to eat and so constructed that it is comfortable. In order to make the hens comfortable it must be free from drafts, dampness, bad odors, or foul air, and constructed so as to be as free as possible from sudden changes of temperature.

A poultry house usually needs more ventilation than is given. Fresh air is far more important than warmth. Fresh air means health but must never be supplied by a draft. The hen was never intended to live in a house. A tree is her natural home; but the northern winters are so cold that it is impossible to get eggs from hens roosting in trees as it takes all they can eat to keep them alive. The poultry house, then, should furnish protection from storms and cold winds, and always provide a clean, dry feeding floor and a clean, dry roosting place. If a house is damp in winter it is usually because there is not enough ventilation, and more air must be admitted in some form to carry out the dampness and bad air. The best system of ventilation for the ordinary poultry house is a cloth covered window which will allow air to pass slowly back and forth through it. This cloth window will need to be open a large part of the time, only closed during storms and the very coldest nights. In most locations, a cloth window should be placed on the south side and hinged in such a way that it is readily opened. Where a house has a south side largely of glass, a part of the glass should be removed and cloth covered frames inserted. In houses with little glass, openings should be cut in the same way as would be done for a glass window, and a cloth covered frame inserted in the opening. As a general rule, a poultry house should have about one square foot of glass to fourteen or sixteen square feet of floor space, and about one square foot of cloth to eight or ten of floor space. The amount of cloth necessary will depend to a large extent on the operator, that is, if the attendant is careful to keep the cloth window open during all mild days, less cloth will be necessary. As a rule poultry houses are too low to permit of the King system of ventilation. Where a poultry house is located away from other buildings so that the wind does not blow over a building and down onto the house, the King system of ventilation may be installed, but where the house is located near the barn or on a side hill, this system will not be satisfactory unless the ventilator tubes are built well up in the air above the house.

THE SIZE OF THE HOUSE

In determining the size of a house, consider the number of fowls that are to be kept in one pen. As a rule, fowls are too crowded for economical production. A flock of fifty hens should usually be allowed about five square feet of floor space per hen. Where the attendant is careful to keep the house clean and the floor heavily littered with straw, less floor space will be necessary. As a rule, it is far better to allow too much floor space rather than too little. The larger the pen, the less floor space will be required per hen. This is shown in Figure 5. One hundred hens will thrive in a pen 20x20 feet, that is, four square feet or floor space per hen, but one hen will not thrive in a pen 2x2 feet. In the large pen, each one has a chance to wander about over the entire floor space thus getting more exercise. As the number in the flock becomes less, the amount of floor space per hen must increase, and anyone keeping eight or ten hens should allow at least ten square feet of floor space per hen, unless he is prepared to give special attention to cleaning and bedding the house. A crowded condition in a poultry house is responsible on many farms for lack of winter egg production.

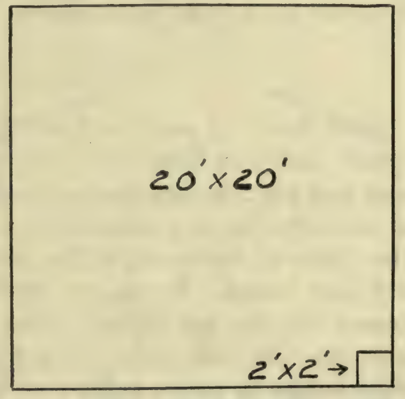


Figure 5.—The large pen is large enough for 100 hens, but one hen could not thrive in a pen 2x2 feet.

Farm hens are frequently kept at the rate of about one square foot of floor space per hen. Where hens have access to the barnyard, straw stack, feed lots, etc., the amount of floor space per hen is not so important as the house then becomes a roosting place and the barnyard is the feeding floor. Many mistakes are made when increasing the number of fowls on farms. When hens become numerous, the barn yard is no longer available as an exercising place for them, with the result that the hens are too closely kept. When 80 hens are kept in a house which is sufficiently large for forty, the results are discouraging. It is always best to sell part of the hens rather than to try to keep more than the house will accommodate satisfactorily.

THE WIDTH OF THE HOUSE

As a general rule, it is far cheaper to build a wide house than a narrow one. A house 20x20 is cheaper than a house 10x40 and contains as much floor space for the hens. A house twenty feet wide, however, will be found impracticable for some types of roofs and will not be found satisfactory where one wishes to keep a number of small breeding pens. There are several common types of roofs used on poultry houses as shown in Figure 6. Just which style of roof should be chosen is largely a matter of personal preference, but the type of roof will be found to influence the cost of construction to quite an extent.

TYPES OF ROOFS

Shed Roof. A shed roof or ''one slant,'' as it is sometimes called, shown in Figure 6—1, is probably the most commonly seen and has the advantage of requiring less cutting of rafters as one rafter should reach clear across from plate to plate. It also turns all the water to the north leaving the south or front dry and warm. It can be used advantageously on narrow houses but can not be used to so good advantage on buildings over fourteen feet wide. This roof is especially unsuitable on wide houses in places subject to heavy falls of snow. If it becomes necessary to build a shed roof wider than fourteen feet, heavy material should be used for rafters or else supporting beams should be run lengthwise throughout the house. On the wide houses this roof does not give a good appearance and should, therefore, be avoided if it is desired to construct a wide house in a conspicuous place. As a rule the roof on a poultry house is built rather flat, not over one-fourth pitch. A shed roof also has the advantage of giving a low rear elevation which makes the house warm, but has a disadvantage in some locations as the high front catches strong south winds, and also heats up rapidly during sunny days in winter. Most of the prepared roofings last longer on a north slope, and, therefore, are particularly adapted to the shed roof type.

Combination Roof. The combination roof shown in Figure 6—2 is merely a modification of the shed roof but is more attractive, giving the same low elevation in the rear and a lower elevation in front. This house can be built wider and is especially valuable in houses more than fourteen feet wide. Built with the same pitch of roof and with the same elevation in the rear this house contains less air space and is, therefore, warmer than the shed roof type. It requires twice as much cutting of rafters as in the shed roof type. In constructing this type of roof it is usually better to build the gable back one-third of the way from the front. That is, in a house eighteen feet wide the gable should be six feet back from the front. This is a type of roof which should be used more extensively than it now is.

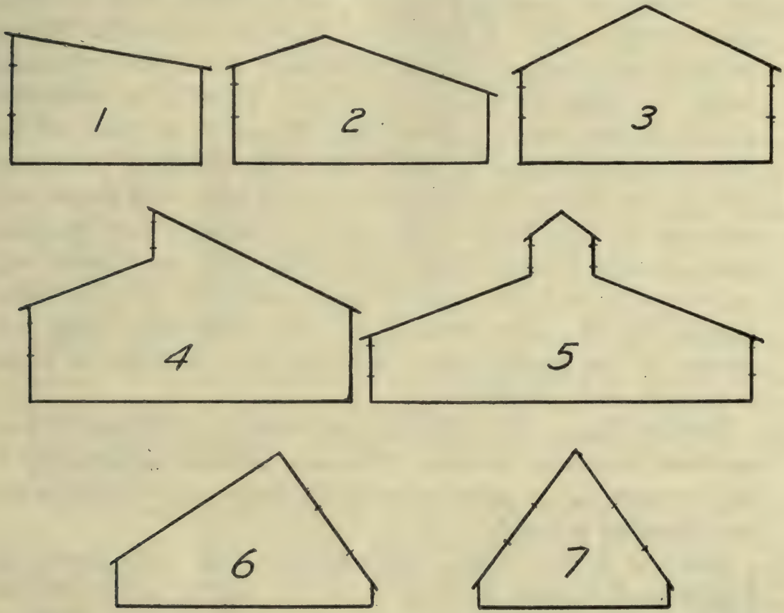


Figure 6.—Different types of roofs used in poultry houses are here shown. 1 is a shed roof; 2 a combination roof; 3 a gable roof; 4 a semi-monitor roof; 5 a monitor roof; 6 a slanting front roof; and 7 an A type roof.

Gable Roof. The gable roof shown in Figure 6—3 is a common type and is very often used because it matches the other buildings on the farm. This type of roof permits of the house being built in any desired width, but gives more air space and makes the poultry house cold. That is, too high a rear elevation is needed to get the front high enough to admit sunshine and to allow for a door. The air space of such a house may be decreased by putting a ceiling from plate to plate, placing the boards so that about one inch space is left between each board. Then cover this with about one foot of straw so that the air can readily circulate from the pen up through the straw. To make this complete, cut a small door or window in each gable end and then have these windows open except during the severest storms. This will be found the most satisfactory method of remodeling many of the old gable roof houses.

Semi-Monitor Roof. This type of roof shown in Figure 6—4 is often used and is practical. Many of the old narrow shed roof houses are remodeled by building an addition on the south side forming a roof of this type. This type of roof is utilized to better advantage in a small stationary house than in a long house. It is unsuitable for a continuous house as the south side is built so low that it is practically impossible to clean out the litter without carrying it to the end of the building. It is possible in this type of roof to reduce the air space and secure sunshine in the very back of the pen, and makes a very practical small poultry house. Many times the south side needs only to be covered with wire, and in mild localities it is to be recommended for the open front type. The south side being low, storms do not readily enter, but this type will not be found suitable in windy localities.

Monitor Type. The Monitor roof shown in Figure 6—5 is excellent for warm climates. It is not, however, satisfactory in cold climates as the house contains too large an air space and is too expensive to build.

Slanting Front Type. The slanting front type shown in Figure 6—6 is found on some of the old poultry houses but has not proven satisfactory.

As a general rule for the farm, it is better to use one of the first four types discussed, and just which type one uses should depend to quite an extent upon individual taste, but the style of the roof and the width of the house should always be determined upon before starting to build.

"A" Type. The "A" type of roof shown in Figure 6—7 may be used advantageously on the small colony house and in the large poultry house where an alleyway is desired in the center with pens on either side. In the small colony house the windows are placed in the ends; in the long continuous house the windows would be built in the roof and care must be taken to make them rain proof. To guard against breakage, a wide screen should be placed over them on the inside. They should

be so made as to be readily opened during the day but require considerable attention as they need to be closed before each rain.

TYPES OF FOUNDATIONS

Portable colony houses should be built on two runners, either of 4x4 material or better, two small trees of some durable wood which may be flattened on top and tapered off at both ends so as to make a satisfactory runner. Usually it is better to treat these runners with some wood preservative before building the house, and then, so far as possible, keep them off of the ground by standing them on blocks or stones. Some use 2x4 pieces spiked together, and as fast as the lower one becomes soft, it is removed and a new one spiked fast. A stationary house may be placed on four foot posts set in the ground at intervals of about four to six feet. Cement posts may also be used or better still, a three foot cement wall built as a foundation under the house. Some houses are made by laying the sills on the ground and replacing them whenever they rot out. This is the cheapest as a good sill will last for several years and can be readily replaced. This method is often used on commercial farms. It is not, however, to be recommended as the sill is not usually replaced until the building has become dilapidated and much lumber injured, costing in the end more than a durable foundation.

Where rats are at all troublesome a substantial cement foundation is a good investment. This should always be brought from six inches to a foot above the surface and then filled in with coarse material such as gravel, etc. In extremely wet locations, especially in clay soil, it often pays to excavate under the entire house and replace with stones or other coarse material, and then connect with tile drains to remove all the water from under the house. In many localities where stones are abundant, poultry houses are placed on stone walls, but unless cement is used to fasten the stones together securely, rats will often work under the house and do a great deal of damage. A loose stone wall soon becomes an ideal dwelling place for rats and should, on that account, never be placed under poultry houses.

KINDS OF FLOORS

In many localities a sand or dirt floor is cheap and advisable. Hens like a dirt floor if it is dry. It makes a natural dust wallow but must be replaced frequently in order to keep the house sanitary. A dirt floor must always be well above the outside surface so that the water drains away leaving the floor dry and comfortable for the fowls. Where a cement foundation is used for the house, one can frequently tamp the surface hard and then fill in to the top of the foundation with sand. This sand should be replaced each year before cold weather.

A cement floor is much easier to keep clean and is durable and rat proof. A cement floor should never be left bare but should be kept constantly covered with at least three inches of sand and with from six to ten inches of straw in winter. When sand cannot be had, extra care should be taken to keep the floor heavily littered so that none of it becomes bare.

In case a cement floor is used, it should always be built so as to be just even with the top of the foundation so that the entire surface is smooth and easily cleaned. Where a cement floor and foundation are placed in a house, it is usually better to put in the floor before constructing the house. The method that has been found most satisfactory is to dig a trench for the foundation, fill it with concrete, erect the forms to the desired height and fill with concrete. As soon as the foundation is at all hard, remove the form from the inside and immediately fill with cinders if available. Tamp hard and then immediately lay the cement floor as shown in Figure 7. By building the cement floor while the foundation is green, the floor and the foundation become well fastened together, making it absolutely rat proof. A cement floor in a poultry house should be reasonably smooth so as to make cleaning easy.

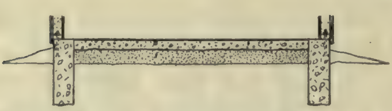


Figure 7.—A well-constructed floor for a poultry house is shown above.

WALLS OF THE POULTRY HOUSE

Walls of poultry houses must keep out rain, snow and cold winds. They should also give strength and rigidity to the house, and must be made in such a way that they can be readily disinfected and cleaned. They must also be reasonably durable and not too expensive. To fulfill the first requirement the walls on the north, east and west are usually made wind tight. Cement blocks have been used in some localities and are giving good service. Solid cement walls should never be used in the poultry house as they become damp and frost covered and can never be said to be satisfactory. Sometimes drain tiles are used in ordinary cement walls making air spaces which help keep out dampness. This method, however, is not used very extensively.

Metal covered walls are becoming more common and give fair service. They must be kept constantly painted in order to be durable. Most poultry houses are built with wooden walls. It is usual to use 2 x 4's about two feet apart for studding and either matched lumber or rough lumber with roofing paper or battens to make the wall windproof. Matched lumber, such as drop siding, is usually placed on horizontally and is used quite extensively as a house presents a good appearance and can be built rapidly. Where siding of this kind is used it should always be painted before being placed on the house, care being taken to have the tongues, grooves, and edges carefully painted. The boards should be placed on the house before the paint becomes too dry. Matched siding of any kind should be dry, well driven together and well nailed so as to be wind proof. Care should be taken that all matched lumber used in this way is of good grade and free from loose knots or other such defects. To add warmth, tar building paper or one-ply roofing paper are often placed between the siding and studding, thus insuring a wind-proof wall.

Many old poultry houses are built with rough boards running up and down and the cracks covered with battens. As a rule, this method of construction is not satisfactory as the battens become loose leaving cracks which are very undesirable. Rough boarding, either perpendicular or horizontal, is also being used quite extensively. When using roofing paper to cover rough boards it is advisable to cement the joints thoroughly and then batten with thin strips, at least every two feet, and then paint the entire outer surface with two coats of good paint. Other walls are constructed by nailing rough boarding to the outside of the studding, covering with tar building paper, and then with ordinary siding such as is usually used on houses. Just which form of wall is best to use will depend very largely upon the locality. With any of these, or with their modifications, which are many, a tight wall can be constructed so that which is advisable depends to a large extent upon the necessity of presenting a good appearance or the necessity of keeping the construction at a low figure. Where the boarding runs up and down, less studding are used and in this way this type of construction becomes advantageous. In the poultry house, however, this requires more cutting and more labor to build. Where the boarding runs horizontally it is hard to construct a wall which will always be wind proof.

SELECTING ROOFING MATERIALS

A great many of the newer poultry houses are covered with prepared roofing materials and are proving very satisfactory. Many are constructed with such flat roofs that shingles are not desirable. Roofing paper is cheaper and, especially on a flat roof, is found to be more advisable. Where the roof is somewhat steep and shingles of good quality can be purchased they will be found to be more durable. When prepared roofings are used, it is always best to use a good grade of boards for the roof. About the most satisfactory method in Wisconsin is to use hemlock shiplap. The shiplapping makes a smooth tight surface and one on which prepared roofing can be laid easily. It will be found that roofing materials last much longer on a smooth surface of this kind and will pay in durability for the extra cost. Some of the older houses were roofed with rough boards and battens. This type of roof is not satisfactory.

MATERIALS FOR PARTITIONS

Wherever there is only one poultry house a partition is always advisable as it permits one to keep the hens separated from the pullets early in the winter and makes it possible later to make up a breeding pen of the best fowls. In a small house, that is one not over thirty feet long, one should use boards for the partitions for about two feet from the floor. The rest may be made of wire or cloth except between the roosts of the different pens where the boards should run to the roof. (See Figure 8.) A solid partition at the back prevents draft on the fowls when roosting and a solid partition at the bottom prevents fighting.

In extremely long houses it is desirable to put in solid partitions, either for each pen or at intervals of about forty feet, according to the size of the pen and the location of the building. In a windy location solid partitions will be found necessary more frequently in order to cut down the draft. Where cloth is used as a part of the partitioning, it will be found necessary to change it frequently. In most places wire will usually be found most advantageous. Long houses should have doors in each partition arranged in a straight line and hung with double acting hinges. In a long poultry house, say a house over one hundred feet long, it is usually desirable to put in a trolley system so as to lessen the labor of caring for the fowls.

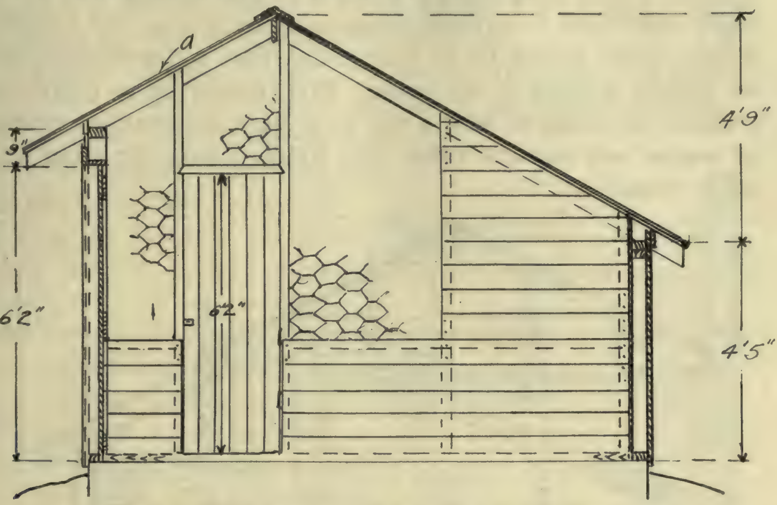


Figure 8.—Proper way to make a partition in a poultry house.

CEILING FOR WARMTH

In either a shed roof, semi-monitor, or combination roof, it is usually not desirable to ceil the roof except over the roosts, see Figure 9. In gable roof houses it is frequently desirable to ceil clear across as noted on page 13. For ceiling around the roosting closets it is usually best to use matched lumber with tar building paper between the lumber and the studding and the rafters. It is also advisable to leave the space open between the upper edge of the last ceiling board and the roof boards. This will allow one to spray into this space when disinfecting the house.

ARRANGING INTERIOR FIXTURES

The interior arrangement should be planned to make it easy to clean the house and care for the fowls.

Perches. The perches should be all on the same level in the warmest part of the pen away from drafts, and should be readily removable. If the perches are not all on the same level the fowls will fight for the opportunity to roost on the highest and the chances are that many fowls will be injured by falling off the perch. The perches should be in the warmest part of the pen as they need the most protection from the cold during the night when the fowls are inactive. At this time the house is also usually colder than during the day. The perches should be easily removable to facilitate cleaning, disinfecting, and fighting mites. They should be so constructed that a disinfectant can be readily applied to all parts. They should be as simple as possible and made in such a way as to have the smallest number of cracks and crevices which offer hiding places for mites and other vermin.

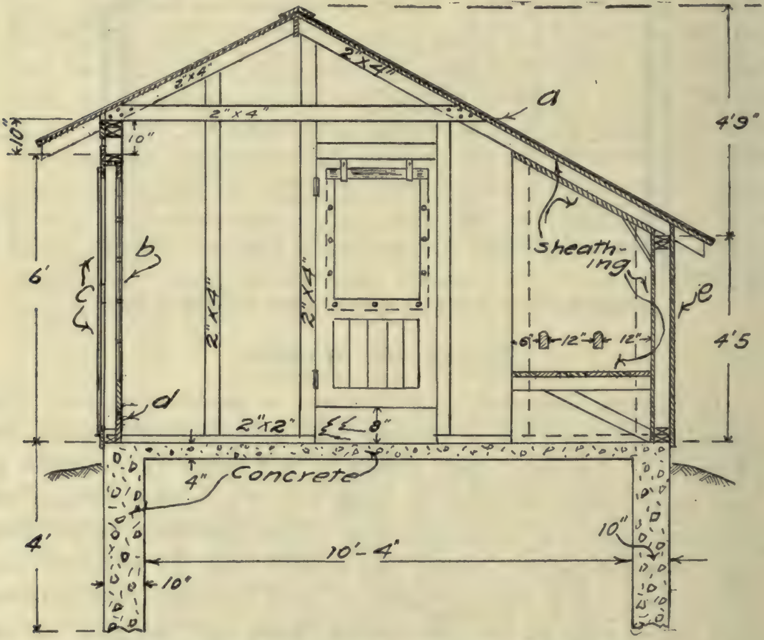


Figure 9.—Cross section of well constructed poultry house.

As a general rule small hens should have about six inches of perch space while the larger hens should be allowed eight inches. In the winter they huddle closer together, but in the summer there should be plenty of room to allow them to spread out. Perches should be twelve inches apart and not closer than fifteen inches to the wall or ceiling. Show birds, especially Leghorns, or similar types should be kept at a greater distance from walls and ceilings. Many good birds are spoiled by "brooming" their tails against the walls.

There are several methods of making movable perches. One of the most common is by hinging them to the wall at the back.

If these hinges are made with loose pins the entire set of perches can be readily removed. The perch itself should not be fastened to the supporting crosspiece which should be notched so that the perch sets into it as shown in Figure 10.

Dropping Boards. Where the hens are fed inside the house, as is usual in winter in many places, it is advantageous to place boards under the perches to catch the manure; thus keeping the floor clean so that it, as well as the rest of the house, can be utilized as a feeding floor. When no dropping boards are used a wide board should be placed in front of the perches on the floor so as to keep the litter away from the droppings under the roost. The use of dropping boards is economical, for it increases the size of the feeding floor. These boards, being close to the fowls, necessitate frequent cleaning, hence more labor, but if the manure is properly handled, enough fertilizer is saved to pay for the extra labor, and frequent cleaning means healthy fowls. On the general farm, dropping boards may be placed in the house in the fall and winter and kept cleaned. When the other farm work becomes pressing in the spring, and the hens are allowed to run at large, they no longer need be fed in the poultry house, so the dropping boards may be removed. Where this system is used it becomes very necessary that the dropping boards be removed in the spring and not left to accumulate a large amount of droppings which would be close to the fowls and very unhealthy. A hinged roost and dropping board is shown in Figure 10. This is a very good arrangement for the droppings are cleaned each morning and then the perches and dropping board swing up and out of the way, thus giving the hens a clear open space. This method is used in the long poultry house at the University of Wisconsin. Before this system was tried there was a great deal of trouble with hens laying under the dropping board instead of in the nests. After installing this system the trouble was greatly lessened.

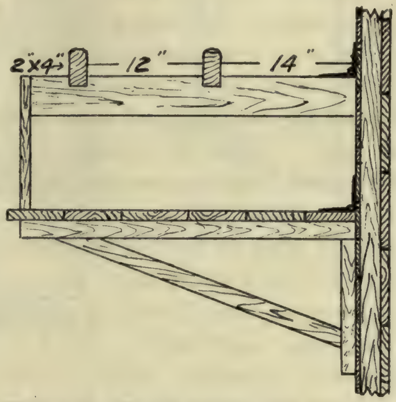


Figure 10—Hinged perches and dropping board.

Nests. Every poultry house should be well supplied with nests which are easily accessible and readily removed for cleaning and disinfecting. There are many methods of arranging nests, each method having some particular advantage over all others. The nests may in some instances be placed under the front edge of the dropping board as in *D* Figure 11 and so arranged that the hens enter from the rear and the attendant gathers the eggs by opening a door or doors on the front side. This is an inexpensive arrangement, as the dropping board forms a cover for the nests. These nests are dark, which is a decided advantage, as hens like to hide, and there is less danger of them learning to eat eggs. It has the decided disadvantage of making the floor under the dropping boards of little use in feeding. It darkens the floor and hens are much more likely to lay in the straw on the floor than in the nests, with the result that many times eggs are left for several days before being gathered. The careful poultryman who furnishes guaranteed eggs will not sell those which have been laid on the floor. In buildings which have a high rear elevation, some of this trouble may be obviated by elevating the roosts and dropping board. This can be done, especially with Leghorns or other light breeds that fly well. For the heavier breeds, it will be found necessary to put in a slanting board with cleats to enable the hens to walk to such a height. It will always be found necessary to keep the floor extremely well bedded. Many heavy hens will jump down from the dropping board instead of walking down the inclined perch and if the litter is thin, they may injure their feet.

Another and quite common arrangement is to fasten small open boxes to the walls of the poultry house. These boxes can be fastened with two 6 d nails and easily removed for cleaning. Where this system is used, if the boxes should accidentally become badly infested with mites, the entire box being of little value, can be burned and new boxes put in. This method does not allow trap nesting, and the nests are not dark, yet it is used very extensively by poultrymen.

Where hens are confined and allowed to lay in open nests of this type, the eggs should be gathered at least twice each day. This is an extremely good practice and should be followed, especially on farms where a good quality of table eggs is being produced.

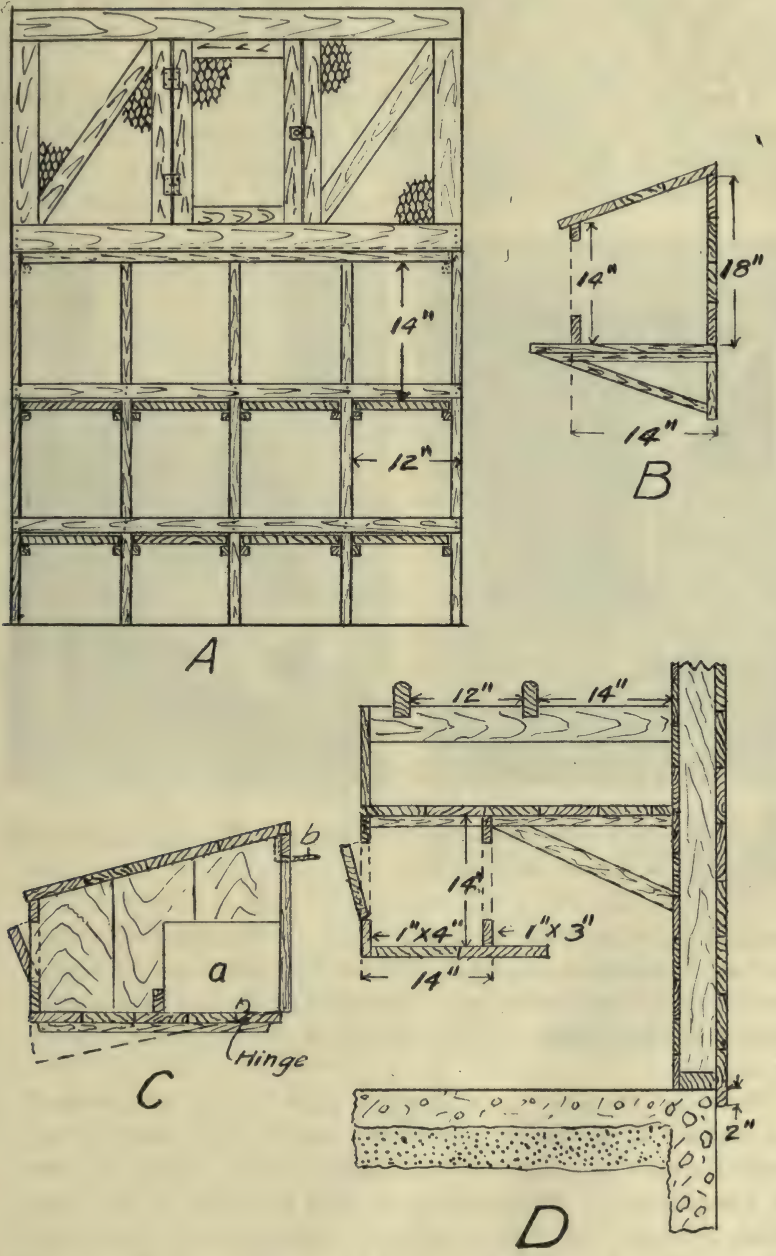


Figure 11.—Different types of nests. A is a tier of nests with broody coop on top. B and C are types of wall nests. D is a nest under the dropping board.

There are several good types of wall nests, some of which are darkened and others that are not. Figure 11 shows two different types which may be used successfully.

A nest for a Leghorn or other small hen should be 12 inches square; for the larger varieties, 14 inches square. The nest should give at least 12 inches head room and be about 14 inches high. They should be kept clean and well bedded with fine nesting material, such as straw or hay. Shavings, excelsior, etc., are not satisfactory as a rule, for they may stain the eggs. Coarse straw and other harsh substances do not make satisfactory nesting material. A hen likes a pliable, soft substance in the nest.

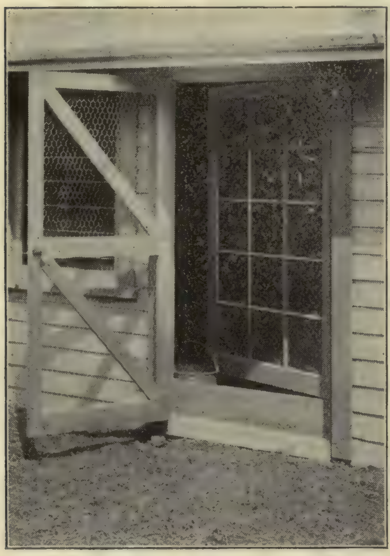


Figure 12.—Double doors are needed when it is desired to have a screen door. The inside door should be of glass and shorter than the other so it will swing over the litter.

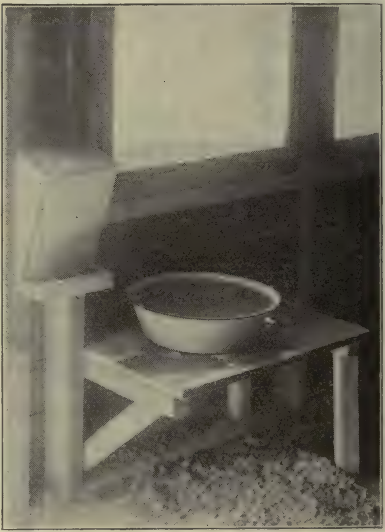


Figure 13.—A stand like the above with water pan insures clean water for the fowls.

Watering Devices. A convenient place should be provided for water. It is best to construct a small stand about 1 foot above the floor and place the water dish on this. This stand can be constructed in the partition so that the hens in two pens drink from one dish. It is, however, usually better to give each pen a separate drinking dish. The water stand should be placed where it is light, and also where it is convenient to empty the dish and re-fill it. As a rule the water dish will keep cleaner if near the south side of the building, as the hens scratch the litter toward the north much more than toward the front of the house. A hen faces the light usually when digging in the straw for her feed and the result is that the litter works back.

There are numerous drinking devices on the market, many of which are valuable. A large number of farmers, however, use either a small pail or pan. A low pail makes a very convenient water dish as the bale enables it to be readily handled with one hand. A pan as shown in Figure 13 also makes a convenient watering dish. Care should be taken not to use watering devices of any kind which have parts that cannot be readily cleaned. A dirty drinking dish is frequently a source of disease and should never be permitted in any poultry house.

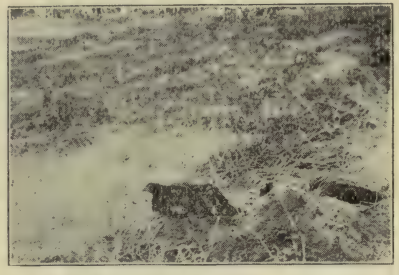


Figure 14. The hen in the above picture is using fresh dirt thrown out of a post hole for a dust bath.

Dust Bath. Fowls need a chance to wallow in the dirt in order to free their bodies of scales and lice. Without this, their bodies become covered with broken down scales which together with lice, cause intense itching. In the winter a dust bath usually has to be provided inside of the poultry house and should be near an open window so that the sun shines on it during a part of the day. For this purpose a common box filled with fine sand to which has been added a little insect powder is quite effective. Sifted coal ashes and road dust, etc., also make effective dust baths. In a house which has a good dry sand floor, or in a cement floored house where the floor is covered with three or four inches of fine sand, a dust bath is seldom needed as the hens will wallow in the sand on the floor.

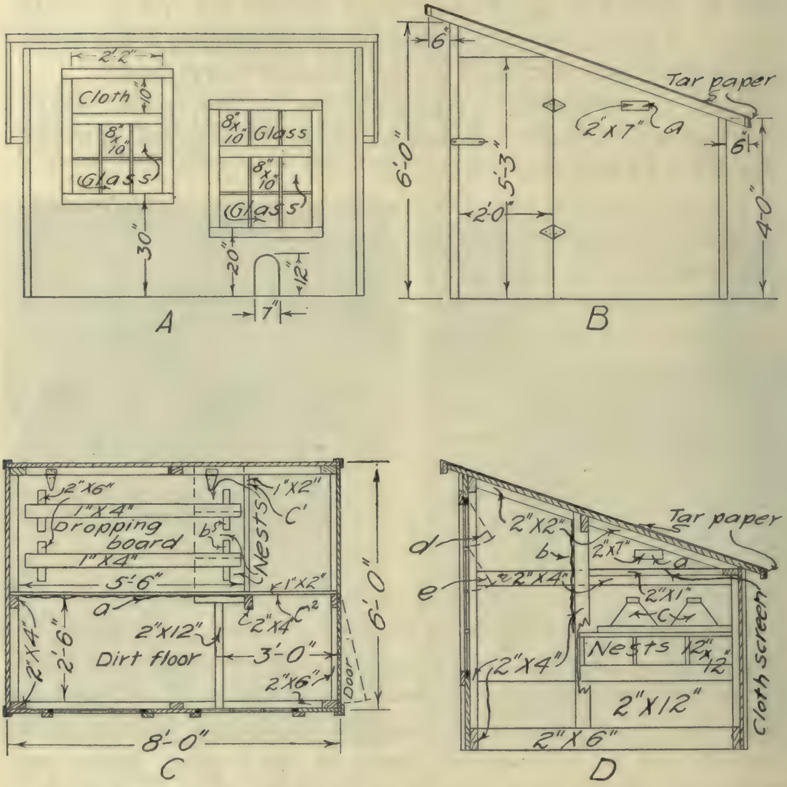


Figure 15—The Ocock chicken house is a convenient and satisfactory house for city lots. It will accommodate 15 individuals if good care is given the flock. A dirt floor is shown at the left in C. At the right in C is a board floor on which the straw litter is placed in winter months. A piece of 2x12 inch material is used as a partition, to prevent the straw from getting over on to the dirt, and is shown in D. The perches, c, on the dropping board are movable to make cleaning easier. The dropping board is hinged and should be swung up as high as the cloth screen during the day, especially during the winter and early spring. The nests are open under the dropping board and have small doors on the side next to the flooring for removing the eggs. The nests are so constructed as to be removed any time for cleaning. A cloth screen extends the full length over the dropping boards, roosts, and floored portion. The frame work being shown at c^1, c^2, in C. A drop curtain of canvas is in front to be used on cold nights; this is shown at a in C and at b in D. An opening is made in each end of the house above the screen and is shown at a in B, also at a in D. A cloth screen is hinged above the window in A and is shown open at d in D. The small three-light glass sash above the six-light sash is also hinged and is shown open at e in D. The roof, side wall and ends are covered with tar paper inside in the half which is devoted to the roosts, nests and part of the floored space. The boarding of this house is nailed up and down.

BILL OF MATERIAL FOR THE OCOCK HOUSE

Nail all boards up and down instead of around. Hemlock may be used instead of pine if kept well painted.

Siding, Roofing, Nests, Dropping board and Floor—
270 board feet of 8 inch shiplap, No. 2 pine.

Corner boards, Window casings and Dropping board frame—
6 pieces of 1x3 inch, 16 feet long, No. 2 pine.

Partition—
1 piece of 2x12 inch, 6 feet long plank, No. 3 pine.

Cornice fascia and cloth frames—
2 pieces 1x2 inch, 10 feet long, No. 2 pine, and
2 pieces 1x2 inch, 16 feet long, No. 2 pine.

Rafters, studding and girts—
1 piece 2x2 inch, 14 feet long, No. 2 pine.
2 pieces 2x4 inch, 10 feet long, No. 2 pine.
4 pieces 2x4 inch, 12 feet long, No. 2 pine.
2 pieces 2x4 inch, 16 feet long, No. 2 pine.
2 pieces 2x6 inch, 14 feet long, No. 2 pine.

Miscellaneous—
One 12-light plain rail window, glass 8x10 inches.
One 3-light barn sash, glass 8x10 inches.
One double roll, 216 square feet, 2 ply roofing paper.
Four yards muslin for screens.
Three yards heavy duck for drop curtain in front of roosts.
One pair 4 inch strap hinges for door.
One hasp and staples.
One pair T hinges, 6 inch, for dropping board.

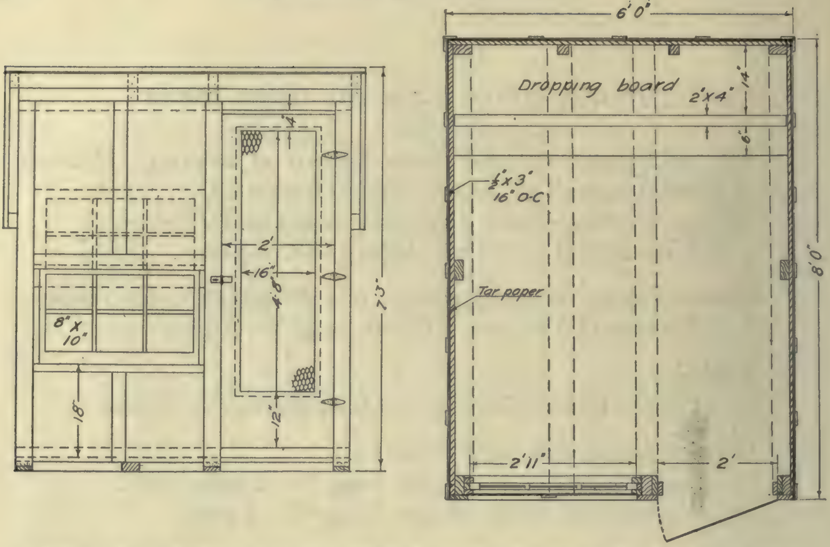


Figure 16.—This portable chicken house is designed for small flocks and will accommodate ten to a dozen chickens. This is 6 by 8 feet, boarded horizontally, differing from the Ocock house, which is boarded up and down. The portable house is covered on the exterior with tar paper, which is put on up and down, all joints being cemented. Over each joint and also between, nail a ½x3 inch strip to prevent the paper from working in the wind. The door has a screen wire covering for day time and a hinged cloth screen to cover the wire screen at night. The roost is movable and is placed 14 inches from the ceiling. Four skids of 4x6 inch material running lengthwise of the building on which the floor rests, make a ready means to move the house from one place to another.

BILL OF MATERIAL FOR THE PORTABLE HOUSE.

Nail siding horizontally instead of up and down. Hemlock may be used instead of pine if kept well painted.

Roof, Sides and Dropping board—
250 board feet of 8 inch shiplap, No. 2 pine.

Floor—
54 board feet of 6 inch matched fencing, No. 2 pine.

Cornice fascia, Dropping board frame and Window casings—
4 pieces 1x3 inch, 16 feet long, No. 2 pine.

Rafters, Studding, Skids and Girts—
7 pieces 2x4 inch, 12 feet long, No. 2 pine.
4 pieces 2x4 inch, 10 feet long, No. 2 pine.
2 pieces 2x4 inch, 16 feet long, No. 2 pine.
11 pieces ½x3 inch, 12 feet long, No. 2 pine.

Miscellaneous—
One 6-light sash, glass 8x10 inches.
One double roll 2 ply tar paper, 216 square feet.
Eight square feet poultry netting, 1 inch mesh.
Three strap hinges 4 inches long.
One hasp and staples.

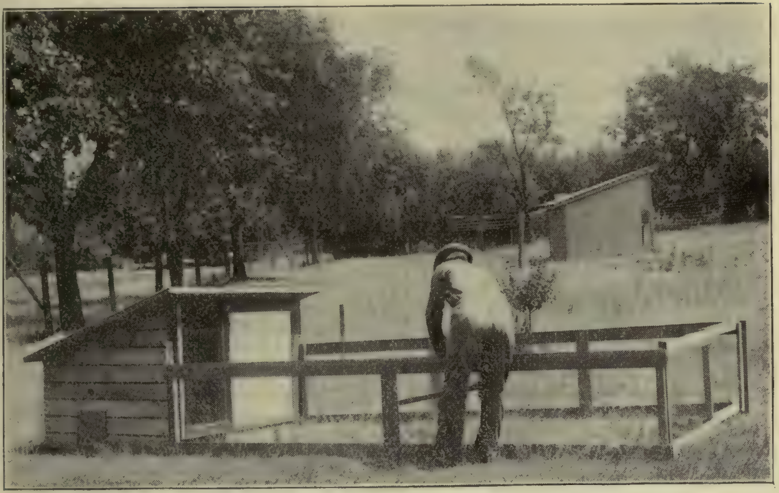


Figure 17.—Outdoor brooder and small run.

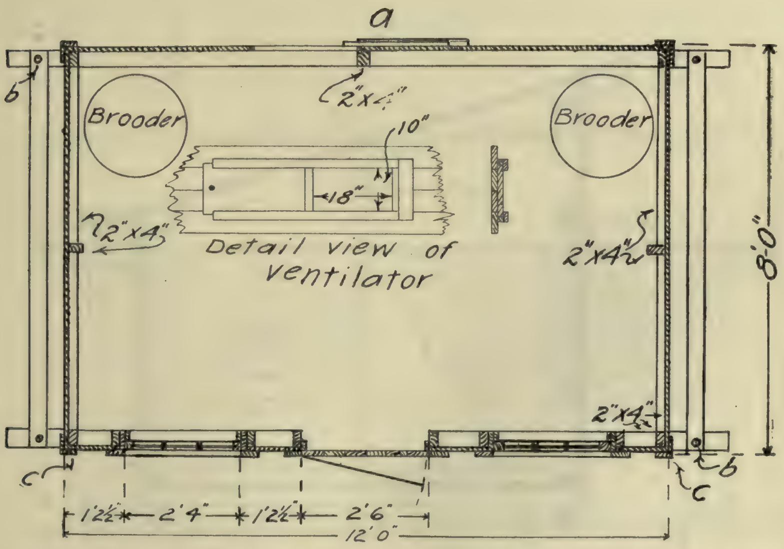
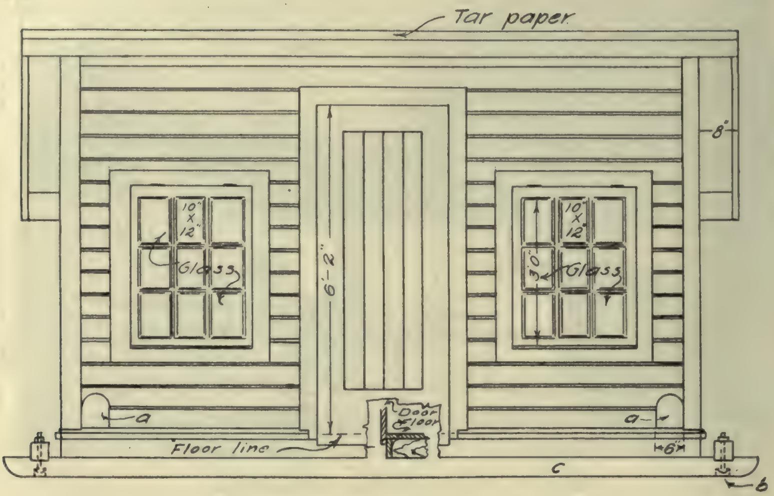


Figure 18.—Brooding house used at Wisconsin College of Agriculture. Note the details of ventilator. Location of ventilator is shown at a. Cross section is shown in Figure 19.



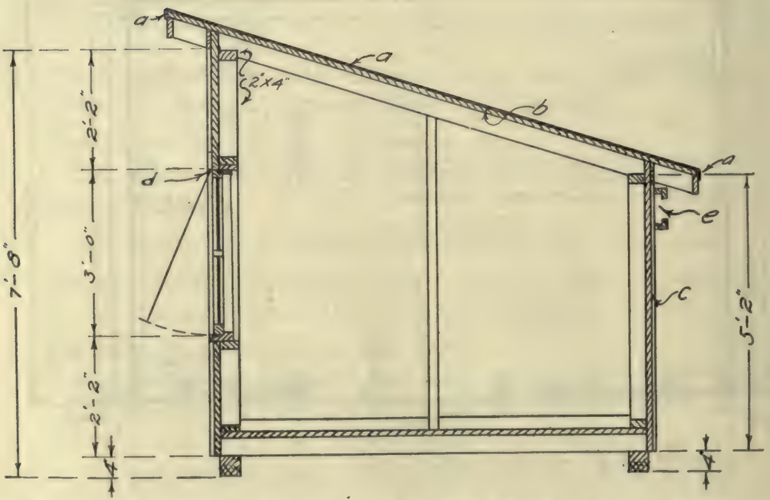


Figure 19.—Cross section of brooding house shown in Figure 18. a is tar paper; b roofing; c corner board; d hinge for window; c ventilator.

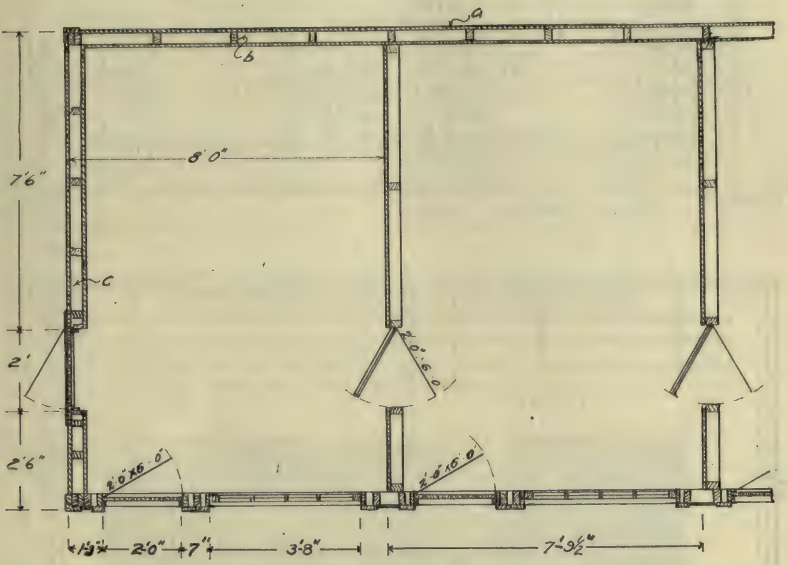


Figure 20.—Two pens of the breeding house at the Wisconsin College of Agriculture. a is drop siding; b studding; c tar paper.

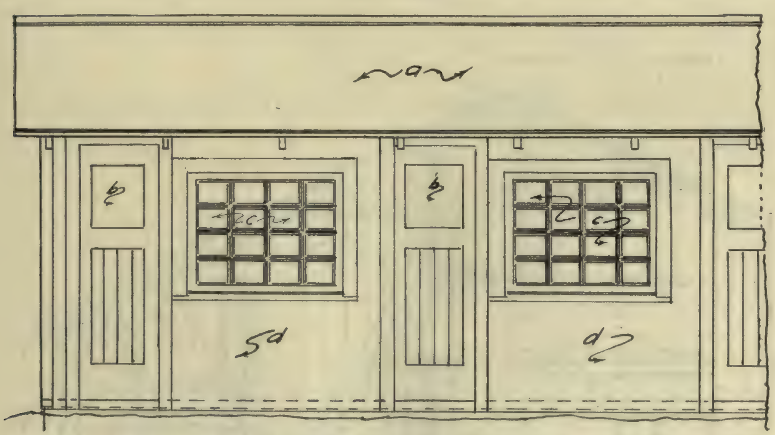


Figure 21.—Front elevation of the breeding house at the Wisconsin College of Agriculture. a is tar paper; b cloth; c 8x10 inch glass; d drop siding.

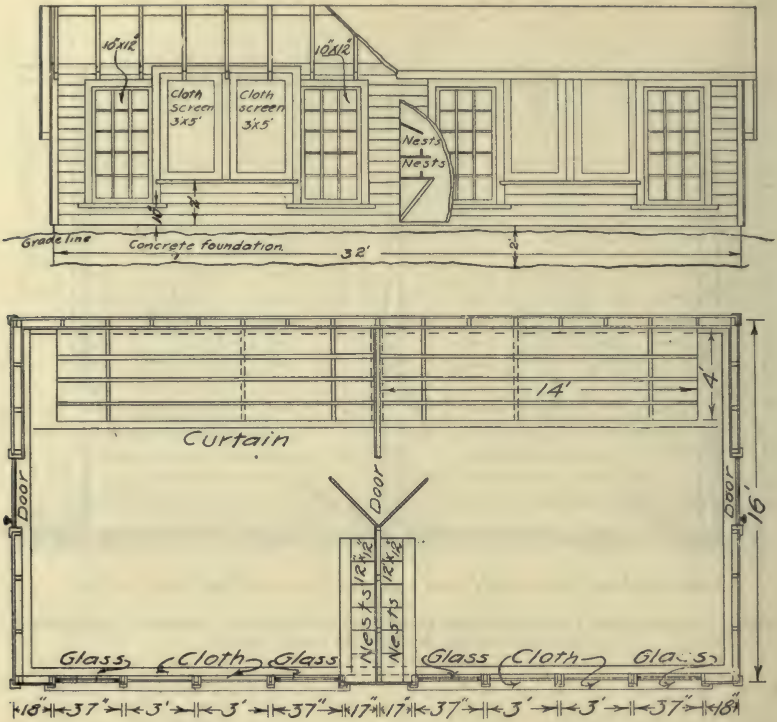


Figure 22.—A two-pen laying house for a small flock. A cross section is shown in Figure 23.

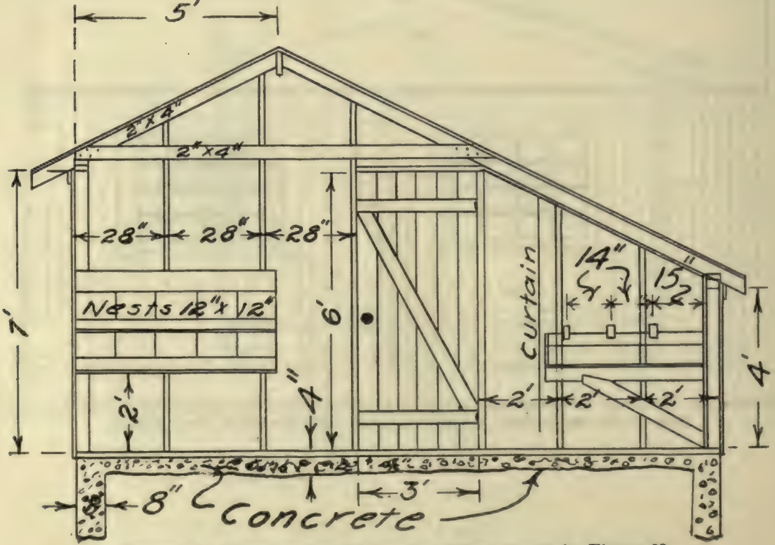


Figure 23.—Cross section of two-pen house shown in Figure 22.

APRIL, 1910 BULLETIN 274

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Poultry Husbandry (Extension Work)

BUILDING POULTRY HOUSES

By JAMES E. RICE and C. A. ROGERS

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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Of the Cornell University Agricultural Experiment Station.

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BUILDING POULTRY HOUSES

PART I. THE PRINCIPLES

Poultry-keeping is an exacting business. The four cornerstones on which success rests are:

(1) Suitable buildings, properly located.
(2) The right foods, skillfully fed.
(3) Good fowls, carefully bred.
(4) Facility and ability to hatch and rear chickens.

To these should be added a willingness to work, a love of the business, and marketing ability. Not the least in importance is the question of constructing the poultry plant.

The poultry house essentials

Buildings for poultry should be economical of construction, convenient, comfortable, dry, cheerful, well-ventilated, and sanitary. Unsatisfactory egg yields are frequently traceable directly to the conditions under which fowls are housed. Moreover, many of our most troublesome poultry diseases are due primarily to improperly located and poorly constructed poultry houses. Such unsatisfactory results rest on the fact that egg production is dependent on the fowl's physical condition. Fowls must be kept in good health if they are to be profitable.

The site of the building

The location should be dry, sheltered and have good air drainage. If the ground is not dry naturally, it should be made so by underdrainage. Damp ground means cold ground, because rapid evaporation cools the soil. It also means unhealthful soil, because the air and sunshine cannot penetrate to purify it. Muddy ground means dirty feet, and dirty feet make dirty eggs.

A low place, though more sheltered from the wind, may be many degrees colder than a higher place a few rods distant. Cold air settles in low places, therefore avoid locating poultry houses where cold air can settle. Secure warmth by building in the lee of a windbreak or a hill, or in front of farm buildings. Buildings that face the south will get the largest exposure to the sun's rays, and other things being equal they will be warmer and dryer and more cheerful. An eastern exposure is

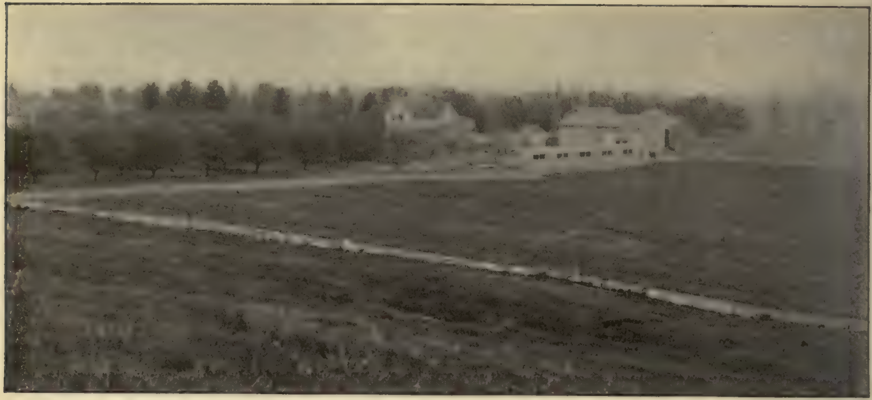

FIG. 32.—*A desirable location for a poultry building*

usually preferable to a western exposure, barring prevailing winds from the east; like flowers, hens prefer morning to afternoon sun.

Fig. 32 shows a desirable location, protected on the north by an orchard, and on the west by a hill, the land well drained and sloping gently to the south and east. It is also closely connected with the general farm buildings. To the north and only a few rods away is a highway, from which passersby can see the fowls in the orchard, an excellent advertising feature.

The location of the building

The poultry plant should be laid out with a view to saving steps. The location of poultry houses has much to do with their convenience and the saving of labor. Time is money. A man would have to walk 1,320 feet to go the rounds of the 16 houses shown in Fig. 33. To feed fowls three times, water once, gather the eggs once, and clean house once daily, would require six trips a day. The attendant would then walk 7,920 feet a day, or 547 miles a year. Walking four miles an hour, it would take 136 hours, and at 12½c an hour would cost $17.00. If the 16 houses are brought together into one continuous house (Fig. 34), the attendant would make the round by walking 540 feet. Six trips a day would make 3,240 feet a day, or 223 miles a year, taking 55 hours and costing $6.87 per year, a saving of 324 miles, of 81 hours, and of approximately $10.00 a year. A horse and cart to carry the feed and water, eggs, litter, cleanings, etc., in case of the colony plan, and a trolley through the contінous house, could be made to save two or three trips a day, reducing the amount of travel proportionately. A system of hopper feeding would still further save a trip daily.

Colony houses are usually located about 150 feet apart, which is twice the distance indicated in Fig. 33. Therefore, if houses are 150 feet apart the distance to be traveled is twice as great. Yet notwithstanding the amount of labor required to do the extra work in connection with the colony plan, there are decided advantages. The fowls are scattered so that the ground does not so quickly become impure and the sod destroyed near the houses. The colony-house plan avoids, to a large extent, congestion of large flocks. Unless a system of ground grain hopper feeding is practiced, however, and care exercised in feeding the whole grain, there is a tendency when each colony is not fenced in for the fowls to congregate at the side of the farm where the attendant begins to feed. The colony system is commended specially for the breeding flocks and for rearing chickens. The most profitable method of handling fowls for egg production is in large houses containing 500 to 1,000 hens in flocks of 50 to 100. These flocks should be kept separate in the houses during the season of confinement and allowed to run together in a large park without interior fences during the remainder of the year.

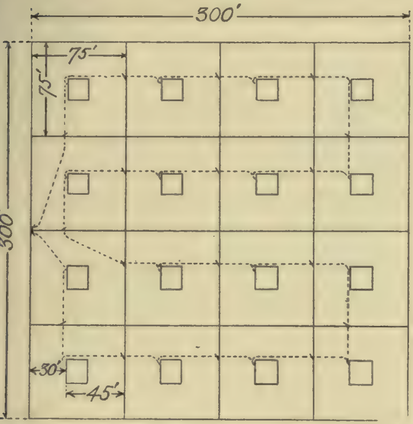

Fig. 33.—*A long walk with houses far apart*

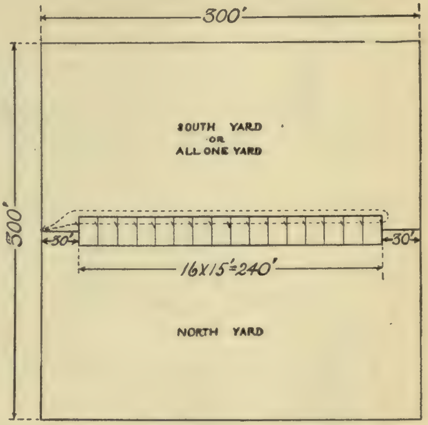

Fig. 34.—*Save time and expense by bringing pens together in one long house*

The size of the building

The form of the building influences the cost of construction. The size and shape of the building will depend, first, on its purpose and, second, on the nature of the land on which it is constructed. A house built on the colony or separate house plan costs more to build than a continuous house of the same capacity. (Figs. 33 and 34.) One end of each house is saved by bringing two together. Supposing the buildings to be 15 feet wide and 6 feet high on the sides, with a ⅓ pitch gable roof, the lumber saved would amount to 127½ square feet for one house, equal to 2,040 square feet for 16 houses. If the houses were double-boarded it would require 4,080 feet, besides other materials and cost of labor for building. The colony houses are much colder, other things being equal, and are more exposed to the wind. The larger the house, the less will be its cost per fowl capacity, and the less labor will be required in caring for the fowls.

The height of the house

A low house is easier to warm than a high one. The best way to make a poultry house warm is to build it as low as possible without danger of bumping the head. There will then be ample air space for as many fowls as the floor space will accommodate. Too much air space makes a house cold. It cannot be warmed by the heat given off by the fowls. Moreover, walls radiate heat rapidly, thus cooling the air in the house.

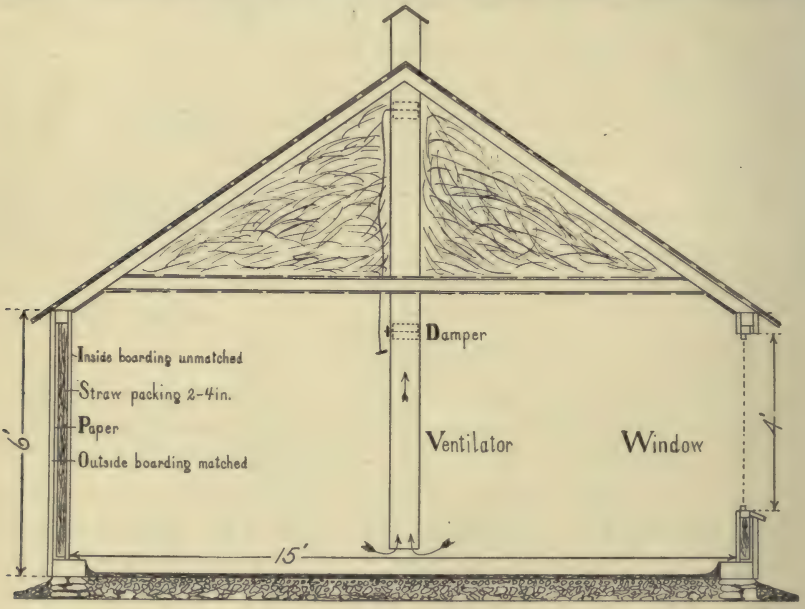

FIG. 35.—*Gable roof house with straw loft*

With the house seen in Fig. 35, which is 15 x 15 x 6 feet to the plate, there would be 1,912 cubic feet of air space, which, with 40 fowls weighing 5 pounds each, would allow 9.56 cubic feet to each pound live weight. This is eight times greater than is recommended for each pound live weight for other animals. The ⅓ pitch, gable roof alone has 562 cubic feet air space, or 2.81 cubic feet air space to each pound live weight.

The lower the roof of the house, the less square feet wall surface will be exposed on the sides and ends and hence the warmer the house will be, other conditions being equal.

A house 100 feet long and 15 feet wide, having sides 5 feet high, would have 460 square feet less wall surface exposed than one similar in type having sides 7 feet high.

The working unit in building a hen house is the floor space and air space required for each fowl. A safe working rule is about 4 to 5 square feet floor space, and 8 to 10 cubic feet air space for every fowl. The lighter breeds, because they are more active and restless, require nearly as much room as larger breeds.

The shape of the house

Square houses economize lumber. The nearer square a house is, other things being equal, the less number it will require (Fig. 36). It is 72

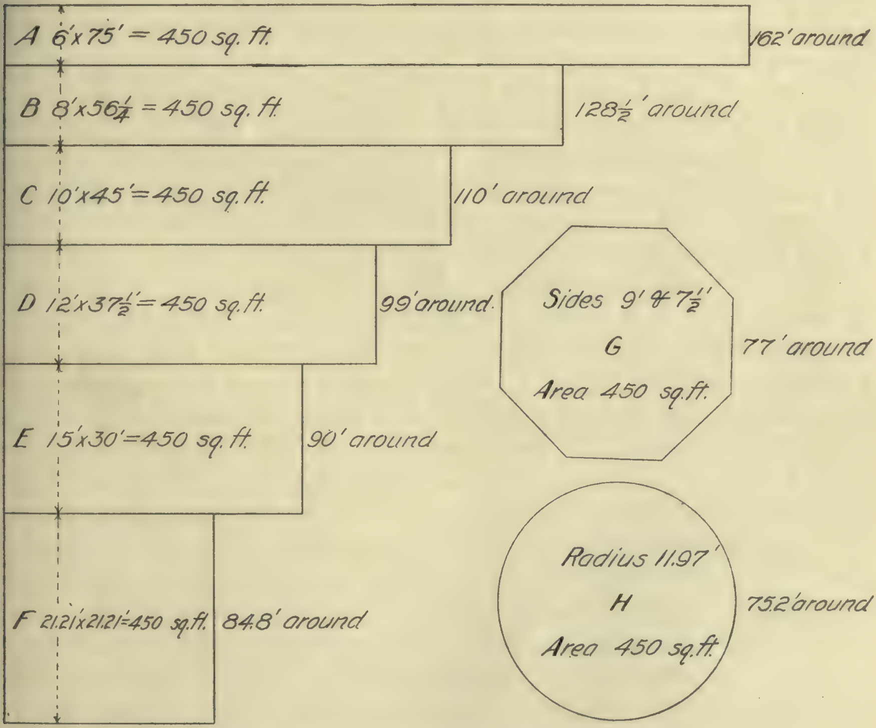

Fig. 36.—*Square houses are more economical*

feet farther around Fig. 36-*A* than it is around Fig. 36-*E*, which has same number of square feet floor space. If the sides of the house are 6 feet high, then one thickness of boards would take 6 times 72 or 432 square feet. If the house is double-boarded it would be twice as great, i. e., 864 square feet, besides the extra material required for 72 feet of framework, building-paper, nails, labor, foundation, etc. The long, narrow house is colder because it has 432 square feet more of exposed surface than house *E* having the same floor space. Similarly it will be found in comparing Fig. 36-*A* with Fig. 36-*F* that there is a still greater saving. and that in comparing Fig. 36-*A* with Fig. 36-*H*, which has the smallest possible area for a given square foot floor space (450 sq. ft.), the distance around Fig. 36-*A* is 87 feet greater than around Fig. 36-*H*. There would be also the same relative increase in the square feet wall surface exposed to the cold and the extra cost of building the walls in Fig. 36-*H* as compared with the other types of houses.

The form of the roof

The roof is the most expensive part of a poultry house, because, as a rule, it covers only one floor and must be made water-tight. The style of roof greatly influences the cost. It takes the same amount of material, however, to build a gable roof, a one-slope roof, or a combination roof, if the pitch and the ground plan are similar (Fig. 37). The shape of the roof determines the height of the sides and likewise the cost of the structure. If we assume that the window is 6 feet high in a building 15 feet wide, it would be necessary with a gable roof to have both sides of the house the same height. This makes more interior air space than is necessary and requires that the rear wall be 1½ feet higher than would be needed with a one-slope or combination roof. A one-slope roof will necessitate extra lumber to build 6 feet higher in front than is required by the combination house. (Figs. 37 and 38.) If an alleyway is required along the back of the house, or if a large garret space is desired, the gable-roof house will be the most economical to build. (Figs. 35 to 40.)

If these three styles of houses were built so that each required the same amount of material, having the same pitch of roof and the same floor space, they would be as represented in Fig. 39. This makes the one-pitch or one-slope roof too low in the rear for convenience.

The steeper the pitch, the greater the comparative expense of a shed-roof house over the gable or combination-roof house. The steeper the roof the larger the roof area, hence the greater cost for roofing and the longer the roofing will last because of its steeper pitch. Most roofs can be ¼ pitch. Shingle roofs should generally be ⅓ pitch. Paper covered roofs can be flatter.

Each form of roof has advantages and disadvantages. The single-span roof is the easiest to build (Fig. 40-*A*). It gives the highest front exposed to the sun's rays, which are reflected back, drying the ground and making a warm shelter. It throws all the rain water to the rear, lessening the length of eaves-trough one-half and keeping the front of the house dry where no eaves-troughs are used. It allows the windows to be placed high. A tarred paper roof will last many years longer if the slope is toward the north. The one-span roof is cooler in summer if not exposed to the vertical rays of the sun. It is especially recommended for houses not over 16 feet deep. The gable roof provides for a large garret space which can be stuffed with straw, making the house warmer and dryer. (Figs. 35 and 40-*C*.) The combination house shares in the advantage and disadvantages of the others. (Fig. 40-*B*.) It furnishes the best head room with the least cost for building material and the least air space for a given height in front.

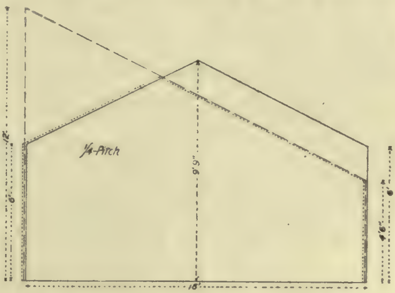

FIG. 37.—*Which is cheaper?*

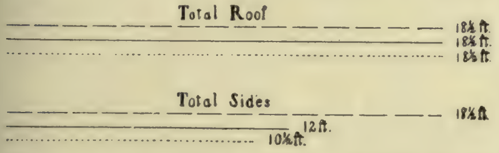

FIG. 38.—*Comparative amount of materials needed for houses with different styles of roof*

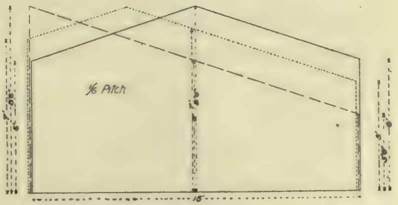

FIG. 39.—*These three houses require the same amount of material*

To provide the necessary height for sunlight in front and working room in the rear, the combination type saves siding material on the north wall when compared with the gable type, as will be seen by the distance between plates in Fig. 37, and on the front over the shed-roof type, as represented by the distance between plates, Fig. 37. For houses 20 feet wide or more the gable (Fig. 40-*C*), half monitor (Fig. 40-*E*), monitor (Fig. 40-*D*), or combination roof (Fig. 40-*B*), is preferable. The half-monitor is desirable on very wide houses that face the south, and especially when a central alleyway is necessary. The upper window throws the light far toward the rear. The monitor is particularly adapted to houses facing east and west, where advantage must be taken of the morning and afternoon sun.

There are other styles of roof, such as the A-shape, hip-roof (Fig. 40-*F*), etc., which are desirable only under particular conditions. The A-shaped roof is the simplest in construction, but does not provide good head room. The hip-roof provides the largest floor space for a given amount of material in sides, ends and roof. Like the *A* house it is adapted only to single or double pen houses.

Roofing material

The material to be used will depend upon the pitch of the roof. Shingles require a ⅓ pitch, or steeper. Prepared roofing papers can be used on roofs nearly flat. A shingle roof being of loose construction is cooler in the summer as well as in the winter. The low-pitched, tight-papered roof is warmer in the winter and very warm in the summer.

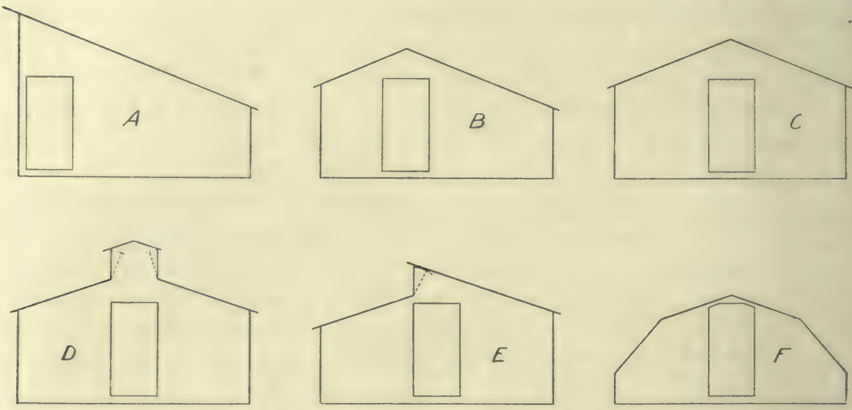

FIG. 40.—*Types of roofs*

The foundation

In the foundation the essentials are durability and dryness. Foundation walls should be built deep enough to prevent heaving by the frost, and high enough to prevent surface water from entering; heavy enough to support the building; economical as to cost of labor and materials, and rat-proof. Wood posts lack durability, permit the wind to blow under the house and are likely to settle. Loose-stone walls do not furnish a smooth surface for the sills and are likely to fall down. Stone walls laid in mortar require a skilled mason to construct and, therefore, are too expensive.

Fig. 41 shows six methods of constructing foundations and floors. Fig. 41-*A* shows the loose-stone filled trench for drainage, wide concrete top wall with cement floor laid before sills are placed. This is a tight and substantial construction and very desirable. Fig. 41-*B* is the same as *A* except that the outside wall is beveled. To do this the wall must be built wider than the framework of the house. This is not desirable. Fig. 41-*C* shows how a light concrete cap can be placed on a large, loose-stone foundation. The sill is imbedded in the concrete by building the floor level with the top. Fig. 41-*D* shows the same type of construction as *C* except that tarred paper is laid between the loose-stone drainage and concrete to prevent moisture from passing upward. The sill is on top of the cement foundation and above the level of the floor, which must be made after the framework is up. Fig. 41-*E* shows a loose-stone wall with the floor on a level with the surface soil, which will permit water to enter. Note the concrete cap to prevent water entering the top of the foundation on the inside of the sill. Fig. 41-*F* indicates a common method of laying a board floor. If a good circulation of air is permitted under the floor the boards become cold. If the air does not circulate freely the floors are likely to rot quickly.

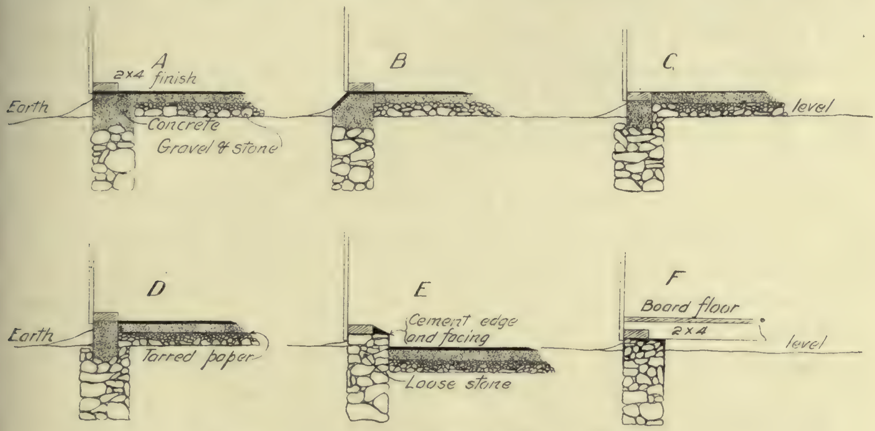

FIG. 41.—*Styles of wall and floor construction*

How to make the foundation

The foundation usually should be made of concrete. This is stronger and cheaper than any other.

After staking out the ground plans as illustrated in Fig. 55 for a house 24 feet long and 12 ft. wide, a trench is dug around the entire enclosure and directly underneath the boundary cord. The depth of this trench should vary from 15 inches in sandy or gravelly soils to 2½ ft. in the very heavy soils. Fill the ditch with cobblestones or coarse gravel to within a few inches of the ground level, then construct the concrete wall on this bed to a level 4 in. to 6 in. above the highest point of land on which the house is located. Observe in Fig. 57 the large amount of filling necessary in the lower places when building long houses on slightly uneven land. This could have been avoided, if desired, by making the level of the floors in the different pens vary with the land. A wall 6 inches to 8 inches thick, of well-mixed concrete, in the proportion of 1 part cement, 3 parts sand, and 5 parts coarse gravel or crushed stone, is solid enough to retain the filling material within, and to support the building above, except in the case of larger buildings or springy soil, when the foundation wall necessarily is built heavier. In such a case the outside should be banked for the double purpose of strengthening the wall and allowing the fowls an easier entrance to the house.

The floors

The essentials of a good floor are a smooth, hard surface for easy cleaning, dryness, durability and economy of construction. It must be rat-proof and high enough to keep out surface water. A common cause of a damp house is a poor floor.

Dampness is fatal to hens, therefore drain to promote dryness. It is better by far to have a cold, dry house than a warm, damp one. The warmer the air the more moisture it will hold. When this moist air comes in contact with a cold surface condensation takes place which is often converted into hoarfrost. This may account for damp floors. The remedy is to prevent moisture in the house as far as possible, by cutting off the water from below. The water-table is the same under the house as it is outdoors. The water rises by capillary attraction. Dirt floors are, therefore, likely to be damp. They require frequent filling in of new soil if they are to be kept sanitary. Stone filling covered with soil is hard to clean, and only partially keeps out dampness. Board floors are short-lived if the air is not allowed to circulate under the house. If the foundation walls are not tight the floors are cold. In any case they harbor rats. A good cement floor is as cheap as a good matched-board floor, counting lumber, sleepers, nails, time, etc. When properly made it is good for all time. It is practically rat-proof, easily cleaned, and perfectly dry, cutting off absolutely all the water from below. If covered with a little soil or straw, or both, as all kinds of floors should be, it will be warm.

The concrete floor is unquestionably the most desirable for most poultry houses. It is rat-proof, sanitary, easily cleaned, dry, and relatively cheap. Usually the roof and sides of the house are built before the floor is put in, so as to protect the setting concrete from the sun. The layer of concrete may not be thicker than 1½ to 2 inches. It may be made of the same proportion as used in the wall construction (1 part Portland cement to 3 parts sharp, clean sand, and 5 parts gravel). An important factor to be observed in the floor construction is to separate the concrete from the earth by 4 to 6 inches of porous material, such as cobblestones, gravel or the like. This layer prevents moisture from coming up through the earth and concrete into the litter, as it would if the concrete were placed directly on a heavy soil. Furthermore, having the floor above the outside level prevents surface water from entering.

A common practice when laying concrete is to use a half inch of richer material for a finishing coat to make a hard, smooth, wearing surface. This practice requires more of the expensive materials, more time in laying, and greater skill in doing the work. The desired smoothness and hardness is nearly as well secured by mixing the concrete rather watery and then, after tamping and leveling, troweling the surface sufficiently to bring the water and cement to the top. It is desirable to have at hand a rich mixture of mortar for filling in the small holes and pockets left after the first rough smoothing.

The walls

The walls must be built to provide warmth, dryness and strength for the house, ease of cleaning and disinfecting, economy in construction; and durability. Warmth is secured by tightness of walls, floor and roof, to prevent the cold air entering and warm air escaping. Dryness is brought about by providing walls that are not likely to condense moisture, and arranging for the removal of moist air before condensation takes place.

The walls should be tight. Matched lumber is cheaper in the end than unmatched with battened sides. Planed lumber usually will pay for the extra cost in the saving of paint and brushes. When laying building paper always make the laps tight.

Fig. 42 shows nine methods of constructing walls. Fig. 42-*A* is rough, single, unmatched boarding. This is too loose, cold and draughty. Fig. 42-*B* is the same, with battens over the cracks. Battens are nearly as expensive as double boarding if narrow lumber is used. It is not a tight construction. Fig. 42-*C* is single, matched board, planed on both sides. This will answer all purposes for most sections in New York State.

Fig. 42-*D* is the same as Fig. 42-*C* with heavy building paper on the outside. Figs. 42-*A* and *B* are greatly improved by the use of a heavy, durable paper; however, paper makes painting unsatisfactory and light or brittle papers are not sufficiently permanent to warrant the expense. Dark colored paper should not be used because it absorbs the heat and makes the house too hot in summer; it also is unattractive. Fig. 42-*E* is the same as Fig. 42-*C*, with matched board wall inside, forming a dead-air space. This is wholly unnecessary and has certain pronounced disadvantages aside from the extra expense. In a dead-air space the air soon becomes as cold as the outside boarding and in turn, by contact, cools the inside boarding which in turn cools the air in the house. This is especially true on the north side of the house where a dead-air space between the walls will become cooled during the night and will not warm up so rapidly in the daytime as the air within the pen. This creates a tendency for the moisture in the warmer air of the pen to condense when in contact with the colder rear wall, thus making the walls and floor damp and frosty. Fig. 42-*F* shows a wall similar to Fig. 42-*E*, except that the space is filled with straw or other packing material. It is warmer because better insulated, but is expensive and is not to be recommended. Fig. 42-*G* is similar to Fig. 42-*F*, except that the inside boarding is loose and permits an interchange of air.

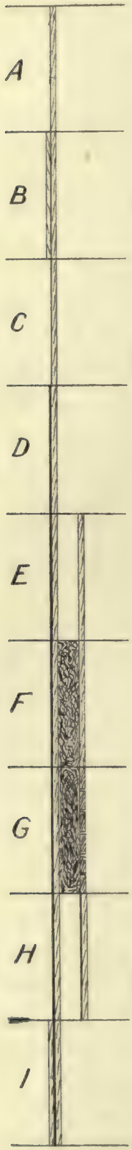

FIG. 42.—*Methods of boarding up the side walls*

Fig. 42-*H* is similar to Fig. 42-*E* with the addition of a second lining of paper, which makes insulation more perfect, but is too expensive and unnecessary. It has the same objection as Figs. 42-*E* and *F*.

Fig. 42-*I* shows a double-boarded wall with paper between. This makes a solid, tight wall and a strong one. The boards are placed vertically, so that every board serves as a post, which makes it possible to do away with studding on low houses except at the points where partitions are placed. With a solid, double wall, heat escapes more rapidly than with a double wall with stuffed space because in the latter contact is broken. In this respect Fig. 42-*I* is to be preferred to Fig. 42-*A*, *B* or *C*, but is unnecessarily expensive. It costs about the same to build a battened double-boarded wall with unmatched boards, solid together with paper between, as it does to make two single walls of matched boards with one lining of paper and the space stuffed with straw.

Double-boarded walls can be used to good advantage by stuffing the space with straw and separating the inside boards one-half to one inch, thus allowing a change of air within the straw-packed enclosure. Such construction is necessarv only in the coldest regions, and then only on the exposed sides. In addition to being expensive this double construction with straw packing is objectionable mainly because it furnishes a breeding place for lice and mites. For this reason the sides of the house that are in contact with the roosting and nesting compartment should always be made smooth and tight.

When the roosts are placed in the back of the pen it is well to protect the fowls from the extreme cold by double-boarding, above mentioned, or by an arrangement as shown in the illustrations (Figs. 50 and 58, 61, 64), in which there is an open air passage between the two walls from about 2 feet above the floor to part way up the rafters above. This construction allows a circulation of air between the two walls and prevents the cold air on the north from penetrating to the inner chamber, thereby providing greater comfort to the fowls when on the roosts. In the latter instance, summer ventilation can be greatly perfected by using long, narrow trap doors in the rear wall which open near the plate into the air space between the double walls, and allow a passage of air up through this air shute above the roosting room or below the nests into the pen, without creating a draught on the fowls, as shown in Figs. 58, 61, and 64.

The rear wall should be as low as is consistent with needed head room. The low back not only makes the construction cheaper, but by reducing the volume of air and minimizing the northern vertical exposure the house is made warmer.

Front walls may be of comparatively loose construction if the back wall, ends, roof and floor are tight. Slow change of air takes place when only the front wall is of open construction. This is on the principle that it is difficult for air to enter and leave the house through the same opening. The front wall, for the most part, will be used for windows and cloth- or wire-covered openings.

Ceiling

It is seldom desirable to ceil the roof of a poultry house because of the demand for economy in construction. This is especially true in the shed-type house. In building the gable or combination roof, however, it is necessary to use tie beams when the roof construction is very heavy or low-pitched, and these tie beams, unless covered, are used as roosting places by all flying varieties of fowls. By ceiling such pens the fowls not only are kept from roosting above, but the air space is materially reduced and the chamber above aids materially in keeping the house warmer in winter and colder in summer provided there is a circulation of air and not a dead-air space above the ceiling — both equally important. Trap doors in the ceiling and ends can be opened to remove the air in the pens. A loose ceiling covered with straw permits a quiet escape of the moisture-laden air upward to the roof where the moisture escapes when the doors at the ends of the house are opened during the day. Generally, however, simplicity in construction, ease of operation and first cost are all in favor of avoiding high houses with large air space, and do not favor ceiling the house.

Partitions

The partition walls of a long house of the open-front type should be solid to prevent draughts. This is especially essential in the back part of the partition wall where the fowls are roosting. The construction can be made either of solid boards, or boards for 2½ feet up from the floor with heavy cloth the remaining distance. The cloth makes the building cheaper, but is less durable and collects dust. The doors in the partitions should be arranged to form a straightaway path through the entire house and should be located in the most convenient entrance to the pen, having regard to head room and convenience in cleaning, feeding, gathering eggs, etc. For greatest ease, especially when trolleys are used, heavy double-acting hinges are advocated on single doors.

The windows

Windows are valuable in a poultry house in so far as they permit the sunlight to reach the interior of the house to carry good cheer and destroy disease. They should be so placed that there is the least danger of breakage and greatest ease of opening and closing. Sunlight is necessary to fowls. But too much glass makes a house too cold at night and too warm during the daytime, because glass radiates heat at night as readily as it collects it in the daytime. Much glass makes construction expensive. We may allow one square foot of glass surface to about 16 square feet of floor area if the windows are properly placed. The windows should be high and placed up and down rather than horizontally and low (Figs. 58, 61, 64). In the former arrangement the sunlight passes over the entire floor during the day from west to east, drying and purifying practically the whole interior.

The time when sunshine is most needed is when the sun is lowest, from September 21 to March 21. The arrows in Fig. 43 represent the extreme points which the sunshine reaches during this period, through a four-foot window placed with the top 4 feet, 6 feet and 7 feet high, respectively. With the highest point of the window at 4 feet, the direct sun's rays would never reach farther back than 9 feet; at 6 feet it would shine 13½ feet back, and at 7 feet it would strike the back side of the house a little above the floor. In very narrow houses a window not higher than four feet above the floor would suffice. In houses deeper than fifteen feet, however, the window should be placed even higher than seven feet in order to obtain the most desirable conditions.

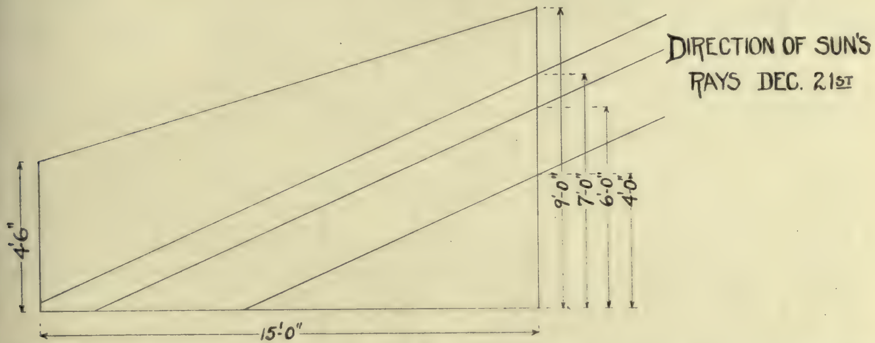

FIG. 43.—*Sunlight reaches farther back into the pens when the windows are placed high. The lines indicate the average direction of the sun's rays*

Small glass in window-sash seriously obstruct the light. Very large lights break too easily and are expensive. Eight by ten is a good sized glass to be used in a 12-light sash, making it about 3 feet 9 inches high by 2 feet 5 inches wide. Use two of these for a house about 15 feet square. Single sash are usually less expensive than double sash of the same size, and the cost for the window frame is less. Single sash may swing from the side, top, or bottom; from the middle vertically or horizontally; or be made to slide to one side. (Figs. 44 *A, C, D, E, F, G, H.*)

There are advantages and disadvantages with each of the windows shown in Fig. 44. Fig. 44-*A* swings from the side. Wall space must be provided in order to swing the window around out of the way. This method of swinging the window is the easiest and admits of the window being placed where it will be least likely to be broken, and where it does not obstruct any part of the window opening, an important matter in the summer season. Heavy hinges are necessary. Fig. 44-*B* makes removal necessary for summer use and cannot be quickly closed when thus removed. Fig. 44-*C* is rather difficult to move because so heavy. Figs. 44-*D, E, F, G,* and *H* cannot be removed or swung out of the way quickly, if at all. Figs. 44-*D, G,* and *H* are likely to be broken by heavy winds. Figs. 44-*G* and *H* make it difficult to have wire over the window opening either inside or out. With Figs. 44-*B, D, E, F, G, H,* and *I* the windows cannot be used conveniently for passageways to clean, spray or litter the pens. Figs. 44-*E* and *F* are likely to fall and break, and Fig. 44-*G* to break loose from the hinges.

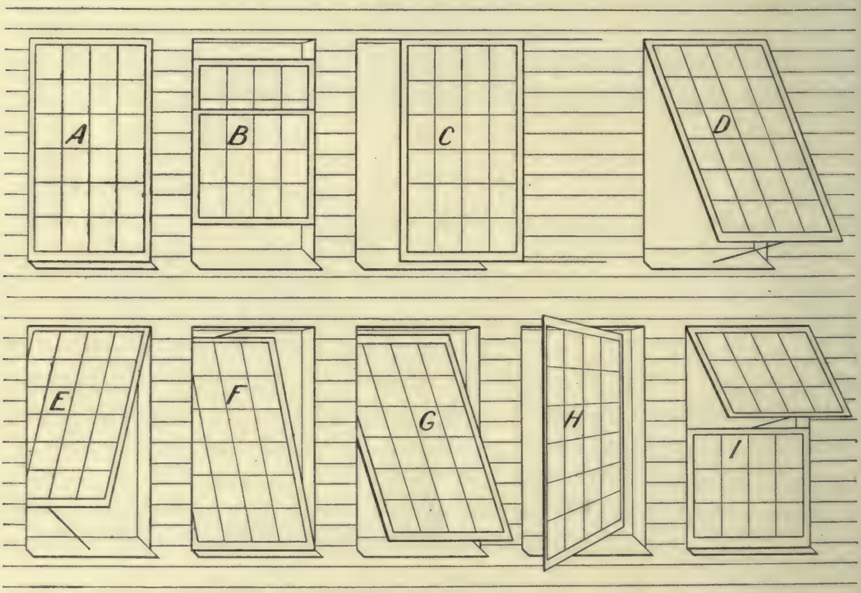

FIG. 44.—*Types of windows and ways of hanging them*

The doors

A good door must be wide enough to permit the attendant to enter conveniently with pails or baskets in each hand, and to be opened and closed with the least possible loss of time.

Fig. 45 shows methods of hanging doors. Figs. 45-*A* and *B* differ only in the fact that *A* swings into the room instead of against the end, and requires the person entering to open the door wider, which is likely to frighten the fowls. Fig. 45-*C* is a "Dutch" door, the upper and lower halves opening separately. While generally not to be recommended, this type of door is found convenient to permit the upper part to be opened to allow the fresh air and sun's heat to enter, while the bottom prevents the wind striking the fowls. The door Fig. 45-*D* opens outward instead of inward, which generally is not satisfactory, owing to the fact that it is not so handy to pull and open as it is to unlatch and push. Fig. 45-*E* is a double door that swings both inward and outward. It is the most unhandy of all except when it is necessary for a trolley to pass through. Fig. 45-*F* swings on double, reversible hinges, which is a convenience and works well, provided the springs are heavy enough to swing quickly and firmly against a rubber pad on the door to prevent back motion. All self-closing doors have the disadvantage of occasionally injuring fowls. The rolling door, Fig. 45-*G*, is not tight enough for outside use, but may be used to good advantage for partition doors. The track should be inclined to permit the door to close quickly and automatically. All doors should be raised above the floor six inches so that the bottom will clear the litter; and a space should be left between the bottom and the sill on interior doors to prevent decapitation of fowls that might get caught while the door is swinging.

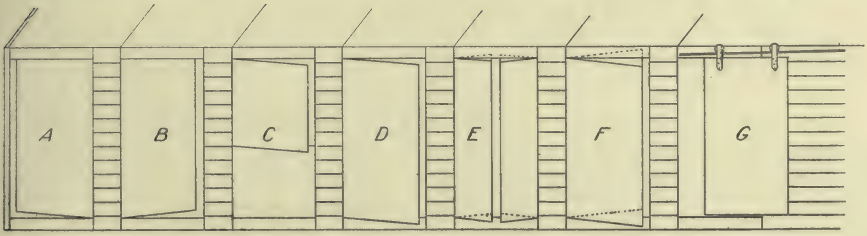

Fig. 45.—*Types of doors and methods of hanging them*

Interior doors should be fitted with spring hinges, weight and pulley or other device to obviate the loss of time in opening and closing latches.

The ventilation

Most poultry houses, if properly built, will not need ventilators. The large amount of air-space in a poultry house makes the systematic change of air less certain and satisfactory than in buildings for larger animals. The fact that the domestic fowl is a hot-blooded rapid-breathing animal, and therefore requires a constant and abundant supply of fresh air, indicates, what in practice proves true, that fowls must live in pure air or they will suffer from illness due to impure blood. Pure air is as necessary to good egg-production as pure food and pure water. Damp air may be removed by ventilators, which will necessarily make the house a little cooler because cool air enters when the warm air escapes. Pure air, however, is of vastly more importance than warmth, though both are desirable. The principle involved in ventilating a house is that warm air rises and cool air settles. It thus becomes easy to secure a change of air when a contrast between the outside and inside temperatures can be secured. This, however, must be accomplished without producing draughts over the fowls, especially while roosting. The best way yet found to accomplish this result is to make the house absolutely tight on all sides except the front, leaving that comparatively open. The openings should be covered with loose muslin or narrow-mesh wire during the stormy weather and on cold nights.

If a ventilating system is to be installed, the best ventilator is one that has an out-take near the floor, with a tight wooden shaft leading up through the warm air of the house to the roof and out at the peak. The wood not being quickly affected by cold, will not be so likely to cause countercurrents of air in the shaft. The in-take air should be received from the bottom on the outside and conducted to the ceiling before being allowed to enter the room. (Fig. 35.) This avoids direct draughts and causes the circulation necessary for the removal of the moisture. The less the difference between the inside and the outside temperatures and the quieter the air the more difficult it is to ventilate. The tighter and the warmer buildings are made, the easier they are to ventilate. The larger the amount of air space the less need there will be for ventilators, provided there is a change of air through windows or doors during the day. (Consult King on ventilation in " Physics of Agriculture.")

Poultry must not be allowed to suffer from cold. This is particularly important at night, when the body is less active. The great difference in production between summer, when hens naturally lay the most eggs, and winter, when they always lay the least eggs, is due to the temperature and the sunshine. Therefore, we must build our poultry houses so that we can overcome this condition as far as possible, consistent with cost and good ventilation.

It will require a perfect system of ventilation and considerable personal attention to keep the air in a poultry house as pure as it is outdoors. It may be found advisable, therefore, in some instances to adopt the scratching-shed plan of house, which allows fowls some discretion in choosing an open-air temperature. This is particularly advisable in poultry houses in which attention cannot be given except in the morning and the evening.

It is as important that houses be kept cool in summer as it is that they be kept warm in winter. Hence the desirability of having a window in the rear (Figs. 58, 61, 64), and also in front (Fig. 58), in order to insure good circulation of air during hot weather. It is also well to remove the glass windows in hot weather.

The kind of pen

The open scratching-shed was the first effort in poultry house construction to permit fowls to enjoy fresh air conditions the year around. It was a radical change from the double-boarded, double-papered and double-glazed so-called " tight warm " house, but in reality a close, damp house and frequently a cold one. At first the scratching-shed had the front entirely open. Later the entire front was covered with muslin; later still, this was reduced in size, the opening being wide horizontally and narrow vertically to prevent the wind and sleet from blowing directly upon the fowls during the day. The house having the cloth-covered front or cloth-covered window has the disadvantage of requiring more personal attention in opening and closing windows to meet changes in the weather than does the house with separate scratching-shed. If the windows are stationary it is not possible quickly to take care of wide extremes in temperature.

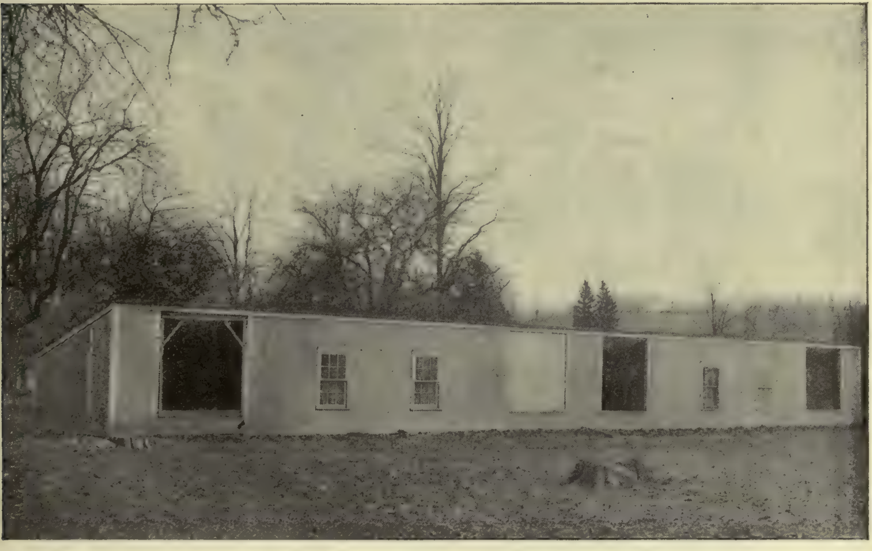

FIG. 46.—*A large scratching-shed house*

The large, open scratching-shed, Fig. 46, is as much too cold and exposed as the old type house was too tight and close. Gradually the open front is undergoing modifications, until it now occupies, in many instances, less than one-quarter the front. With this restricted opening has come a tendency to leave out the partition between the scratching-shed and the roosting-room, thus leaving the entire area a scratching-pen.

The modern open-front scratching-pen has some advantages which for many purposes appear to outweigh those of the closed pen and scratching-shed. The open scratching-pen is cheaper in first cost of construction because one partition is saved in each pen; and less labor is required to care for the fowls because of less doors to open and close.

The fact that fowls can go in and out freely from house to shed seems to be a deceptive form of liberty which they crave and which is a factor not provided in a single, close, compartment house. It provides the fowls an opportunity to escape from one room to another when frightened. Anything that causes uncertainty or suggests danger retards egg-production. Therefore, such a retreat is desirable. This is accomplished by placing the opening through which the fowls pass to and from the shed and the house at the back instead of the front of the partition. It should be raised eight inches above the floor to prevent the litter from being scratched out. When anyone approaches the shed the fowls retreat without alarm to the house, or to the shed if the alarm comes from the other direction. Placing the opening at the back also prevents the wind from blowing into the house.

Exercise is necessary to insure health; scratching-pens provide for this. Fowls do not like confinement. Being in the cooler air during the daytime seems to make them less affected by the cold at night. In practice, fowls are generally found to be more healthy and to lay more eggs in a year when permitted to live in fresh air, either in open-front pens or pens with scratching-sheds, as compared with close-pen houses.

The relative size of the shed and the closed compartment will depend upon the location. The farther north one goes, the smaller should be the scratching-shed and the larger the closed compartment, until in very cold sections the open sheds might be undesirable. In the south the entire front might be open. Ordinarily the pen and shed should be about equally divided in size, if they are to be separated.

There are several ways of constructing pens and scratching-sheds, each possessing some special advantage. Fig. 47 shows twelve styles. Fig. 47-*A* is the open pen without scratching-shed attached. It should contain as many square feet of space per fowl as the pen and shed when they are separate. When the perches are placed along the back they are least in the way and do not obstruct the sunlight, and are most accessible for cleaning, gathering eggs, etc. However, they are along the coldest part of the house and most exposed to the wind blowing from the south through the open windows. Fig. 47-*B* has the roosting arrangement against the partition, presumably the warmest part of the house, made doubly so by placing the roosting compartments of two pens against the same partition. With a wind-shield at the south end of each roosting compartment and with the window opening directly in front, the wind cannot blow upon the fowls while on the perches. This method somewhat obstructs the light, but is very convenient in operation and is to be commended for use in each of the house plans shown in Part II of this bulletin. The perch room must be made shorter and wider than in Fig. 47-*A*, assuming the pens to be approximately square. This, however, is not a serious disadvantage. Fig. 47-*C* provides for scratching-pens with roosting, nesting, and feeding arrangements, but with no doors between the pens. This enables the fowls to have the greatest possible freedom within the house without destroying the flock exclusiveness of separate pens. Fowls will return to their own pens to roost and lay with great regularity. Figs. 47-*D, E,* and *F* show pens with alleyway. The former is by far the more desirable except when a shed-type house is used and the yards are only on the back side. Even then it is a question whether it would not be more satisfactory to have a walk outside the house and thus give the fowls the benefit of all the floor space. Fig. 47-*G* has the advantage of a scratching-shed as deep as the house,

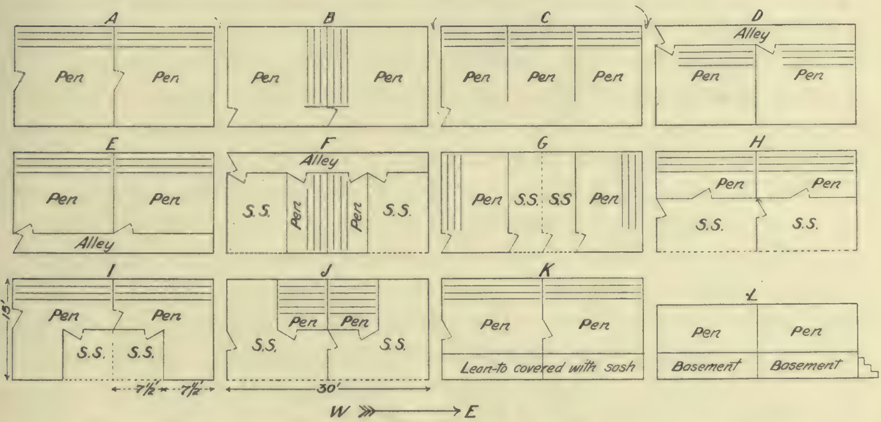

FIG. 47.—*Types of pens illustrating arrangement of roosts, partitions, alleyways and combination pen and scratching-shed*

which provides the fowls with better shelter from the wind. It has the disadvantage of having more doors to open and close. Fig. 47-*H* shows a closed pen occupying the rear part and the scratching-shed the front half of the house. Unless windows are placed in the partition between the roosting compartment and the scratching-shed, the former will be dark and unsanitary because not accessible to sunlight. With many windows in the partition the construction would be expensive. Fig. 47-*I* does away with two doors, thus saving time, but is more expensive to build. It is more exposed to the wind and will make a somewhat dark corner unless a window is placed at the back of the scratching-shed. Fig. 47-*J* is all scratching-shed except a small, warm roosting-room. This would be a little cheaper to build but would not be adapted to the coldest sections and is very inconvenient in cleaning, disinfecting, etc. The front of the open shed should generally be provided with loose mesh cotton cloth door to keep out sleet and snow during heavy storms. The door may be hung at the top and raised by a pulley; or a sliding cloth door can be used. Fig. 47-*K* is an attempt to provide a scratching compartment at low cost of building. It shows low, glass-covered space where the fowls can get to the outside of the house proper without going out upon the ground. Much glass is expensive and liable to breakage, and the framework quickly decays. The building is made inaccessible from the front except for the fowls. The modification of this plan in which only a small part of the front is occupied by the scratching compartment has proved satisfactory. Fig. 47-*L* provides for a scratching-pen below the closed pen. If the former is low it becomes very inaccessible for cleaning, etc. If high, it makes considerable running up and down stairs to get to the pen where the feeding, watering, etc., are done. The plan undoubtedly has advantages in economy of construction, because one roof covers two floor areas which enables one to keep twice as many fowls under the same roof. The fowls will pass from one room to the other without trouble, and they have a natural means of escape to avoid fright. The floors of the pen will be cold whether the scratching-shed front is open or closed, and will make the house drafty unless the tight double floor is used.

The size of pen

The size of the pen will depend upon the purpose for which the hens are kept. Except when small breeding flocks are necessary, large pens are desirable. The best net results appear to be secured when fowls are allowed four to five square feet floor space each.

Small flocks lay better than large flocks. While ordinarily we may expect to get more eggs from a small flock than from a large one it is also true that every time we double a flock we divide the labor. Fifty to one hundred fowls seem to be about as many as it is safe and economical to keep together in one pen as a unit. If more are together, the weaker are crowded and the individual fowl is lost sight of. Fowls may be kept in small flocks of 35, 40 or 50, each flock having its own roosting, nesting, feeding and watering arrangements, the fowls being permitted to run together during certain seasons. Fowls thus kept undoubtedly enjoy great freedom of action, and it is reasonable to suppose also suffer less from confinement and lack of exercise than they do when kept in single pens. To avoid undue crowding in the pens when the flocks are allowed to run together, a hopper system of supplying the ground feed is desirable. Probably not more than five to eight flocks should thus be permitted to run together if at all. This system is now being tested in several places; we would not be justified with our present information to approve or condemn it. In a few instances fowls are being kept in flocks of 200 to 500 in a single pen. In such cases it would seem that the lack of small flock or family units would be a disadvantage, and the difficulty of avoiding crowding and the loss of the individual identity of the fowl would be greater and partially overcome the saving of labor. The poultryman must always decide for himself the happy medium between the most productive small flock of six or a dozen fowls with its excessive amount of labor, and the less productive large flock with its attendant saving of labor. The best sized flock has not yet been determined; and when it is, there will still be modifying factors.

Roosts

Interior fixtures should be portable to facilitate fighting the mites, cleaning and disinfecting. The perches should be in the warmest place, out of the path of draughts and as high as possible without endangering the fowls in descending. The form of perch most to be desired seems to be a stick about two by three or four inches with the narrow edge rounded and uppermost. They should be close, so that fowls can snuggle together and keep each other warm, enough space being provided so that they can separate during warm weather. The usual working rule is 6 to 8 linear inches of perch room, with the perches at least 12 inches to 15 inches apart. They should also be on the same level. When they are on different levels fowls will struggle to roost on the topmost perch, and frequently injure themselves by falling while crowding and fighting. For easiest and quickest work in cleaning, the perches can be fastened together by cross cleats which are hinged at the back and allow the roosts to lift up and fasten out of the way. Under the perches should be a platform to catch the droppings, far enough below to permit cleaning without removing perches.

In long houses the usual location of the roosts is in the rear. This places the roosts farthest from the open front and in the place freest from drafts except in the case of wind blowing through the open windows, and also least in the way.

Dropping platform

For the best sanitary conditions, a tightly constructed droppings platform should be built under the roosts. This makes frequent cleaning easy and allows the construction of the nests directly beneath. It is much cheaper to build the nests in this place than on the wall. The latter construction requires a special inclined cover. Wall nests, furthermore, are too high for heavy breeds, and occupy space which is frequently needed for hoppers, water devices, and the like.

The nests

Nests must be convenient for gathering the eggs and for cleaning. They must also be somewhat dark to prevent the hens from scratching the nesting material out, thus breaking the eggs and learning to eat them. They must be secretive to gratify the hen's natural desire to hide her eggs.

In constructing the nests it is desirable to give at least 12 to 15 inches head room. The nests should be about 14 inches square and 6 inches deep. Hens prefer large nests, and the nests should be deep enough to prevent eggs from being rolled out and to contain enough straw so that the eggs will not strike the bottom. At the same time they should not be so deep that fowls will break the eggs when getting into the nest.

Fine straw is the best nest material; sawdust stains eggs; excelsior wads up and sticks to hens' toes; rye straw is too coarse. Nest eggs should be provided. The hen then feels a sense of security. That is why hens like to lay in the same nests. The nests in Figs. 64 and 66 are constructed as a box framework which rests upon and is hooked to the bottom platform. The construction makes easy cleaning possible by simply loosening the hooks and drawing the frame outward. The back of the nest cleans the platform as the frame is drawn out. Upon replacing and refastening the frame the nests are ready for clean material. The nests can be closed tightly in front by a long-hinged door, making them dark and secretive. The hen enters the nest from the rear through the opening under the platform. Both the nesting and roosting devices for a 20-foot pen should be cut in half for easy handling. Roosting in nests and other unsanitary practices of broody hens and pullets are easily prevented by boarding up just back of the runway where the hens enter the nests, and allowing the fowls entrance to this runway only through trap doors at each end, which are closed at night. (Fig. 63.)

Trap nests can be fitted either into nests beneath the droppings platform or against the wall. Working plans and illustrations of the improved Cornell trap nest can be obtained from Circular 1 of the Department of Poultry Husbandry, or from a later publication on "Poultry-House Appliances."

Fig. 48 shows eight methods of constructing roosting and nesting arrangements. Fig. 48-*A* is desirable when the walls would harbor mites. It must be built firm to prevent swaying while being cleaned. It has the advantage of simplicity and cheapness. Fig. 48-*B* is a compact and complete arrangement. In both Fig. 48-*A* and *B* the perch rack rests on the platform which brings the perches near the droppings. During cold weather fowls occasionally roost on the platform instead of the perches to keep warm and these become soiled. Fig. 48-*C* is too complicated and expensive. In Fig. 48-*D* the nests are too low for convenience in gathering the eggs and a hiding place is furnished for hens to nest on the floor, where the eggs would not be easily discovered. Fig. 48-*D* has the added disadvantage of occupying valuable floor space and being colder, since the air is usually coldest nearer the floor. Fig. 48-*E* does not prevent the droppings from being scratched from the platform and does not provide for nests. Fig. 48-*F* is the most undesirable of all because it permits the droppings to fall upon the floor, thus soiling the litter and

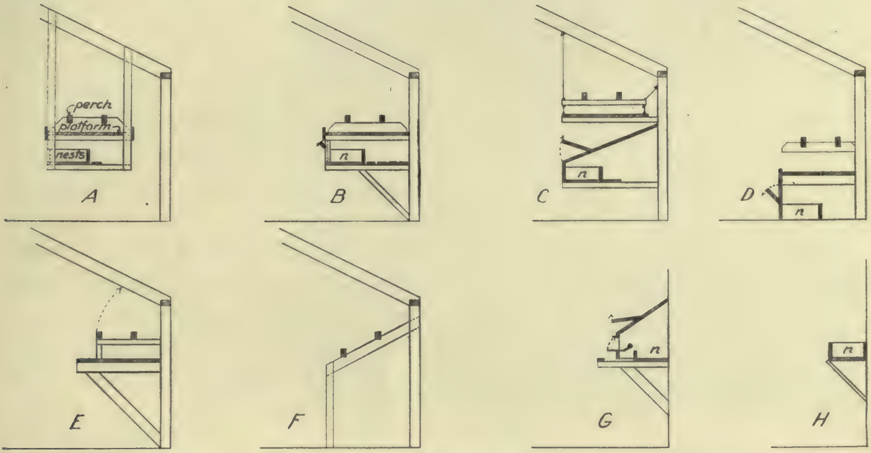

Fig. 48.—*Types of roosting and nesting arrangements*

making cleaning more difficult; it also has perches at different heights, which permit fowls to crowd on the highest ones. Fig. 48-*G* is a wall arrangement for trap nests to be used when the back wall is so low that there is not room for nests under the perches. Fig. 48-*H* is an open wall nest which lacks seclusion and permits fowls to roost upon it.

Alleyways

Alleyways are objectionable in most poultry houses. They occupy valuable floor space which might be better used in keeping more hens or in giving more floor space to the hens usually kept. In houses 12 to 16 feet wide, ⅕ to ¼ the entire floor space is thus occupied, reducing the carrying capacity of the house 20 to 25 per cent, which adds just that amount to the cost per hen capacity. Alleyway houses are cold because they add 20 to 25 per cent to the cubic feet of air space to be warmed by the fowls without increasing the available floor space. They also cause houses to be draughty, forming unobstructed passage for currents of air from one end to the other and out through each pen if the partition is loose. They do not save labor in opening and closing gates if the attendant goes inside the pens to feed and look after the hens. Unless this is done the feeder cannot keep in touch with his flock.

In brooder houses, fattening houses and observation houses where many visitors must be received alleyways are necessary. In the latter the alleyways may be in the center in a wide house extending north and south, or in a narrower house along the back side. In any event they should be well lighted and partitioned to avoid draughts.

The dust wallow

A dust wallow is as essential to a fowl's health and happiness as a water bath is to the health of a human being. By it, fowls scour off the scurf and scales from the skin and rid themselves of vermin. The finer, lighter and dryer the dust the better for this purpose, because the dust must be light and fine to get into the breathing pores of the lice and so kill them. Sandy loam is often better than sand or some kinds of road dust which are cold and heavy. Screened coal ashes lighten up such heavy material. The best place for the dust bath is in the open air of the scratching-shed or in a covered box close to the window where the wallow may be kept dry and warm. Here the

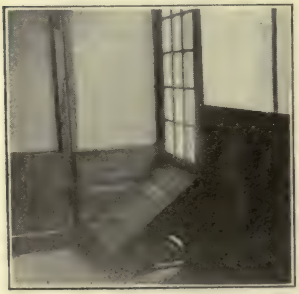

FIG. 49.—*A good covered dust wallow*

dust most quickly settles and the fowls that are not dusting are not compelled to breathe it. Fowls are likely to stand upon the edge of an uncovered dust-box and befoul it.

Notwithstanding the great importance of the dust wallow, there are certain objections to its use. The finer the dusting material the more effective it is in controlling the lice, but the more objectionable it is from a sanitary viewpoint. When clean sand is used, the fowls can get the comfort in the bath without raising a dust; and when tobacco stems or powdered sulfur or lice powder are added in small amounts to the sand, the mixture serves to control the body lice.

In most houses a small box will provide for a dust wallow if screened so that the fowls enter through a small opening. The box can be raised from the floor on legs to avoid using floor space. A desirable covered dust wallow is shown in Fig. 49. In this type of box much of the dust is retained. In practice, however, the fowls frequently come outside of the box to shake themselves. The covered box, therefore, does not entirely overcome the dust difficulty. The windows in the front of the dust box make it light and warm. A small trap door in the cover of the top makes it easy to fill. (Fig. 58.)

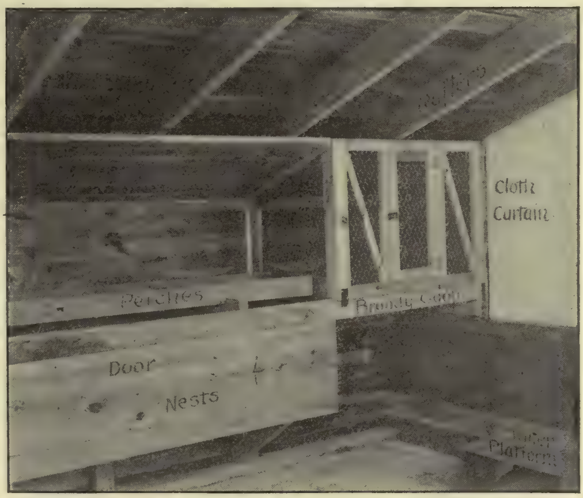

FIG. 50.—*A broody coop is a desirable fixture*

The broody coop

Every pen should be provided with a hanging coop, with slatted sides and bottom, in which to place broody hens or extra males. (Fig. 50.)

Yards and fences

Extensive yards for each pen or colony are expensive. It has been fully demonstrated that fowls from different pens when yarded together

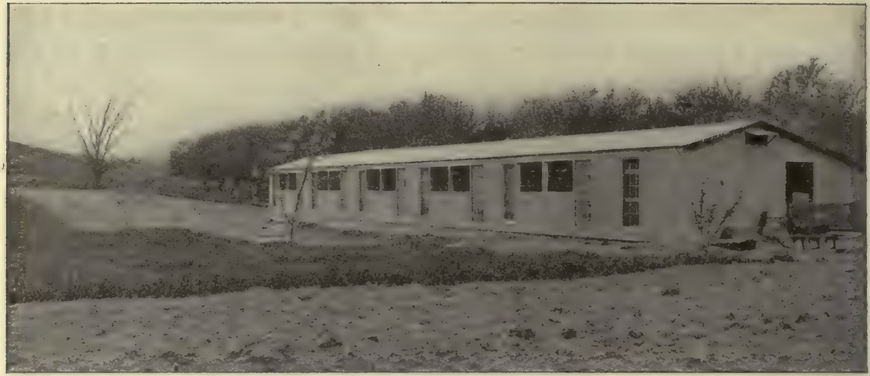

FIG. 51.—*No fences to interfere with cultivation or the liberty of the fowls*

will return to their own home to roost after becoming flocked. In order to teach fowls to return to their own pens release them the first few times late in the afternoon, leaving the partition doors open. Flocks of five hundred to one thousand birds may be allowed to range together, having much greater liberty and allowing easier cultivation of the field, greater accessibility and economy of fences. Compare Figs. 51 and 52. Under these conditions, a double-yard system can easily be practiced in order to make possible the cropping and renovation of the land. Only under a large double-yard system is it safe to house a large number of fowls on the intensive plan, because of the easy contamination of the soil. Under the one-yard method such contamination is very difficult to overcome.

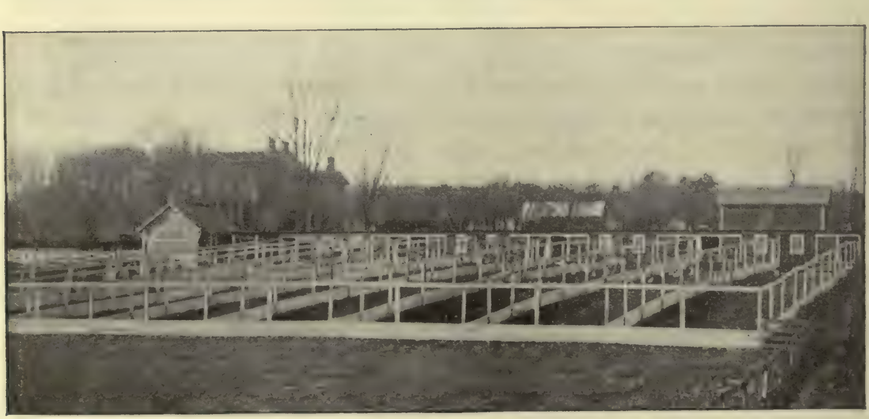

FIG. 52.—*Small yards restrict liberty, require much fencing and increase labor*

The free range plan can be applied to the colony system as well as to continuous housing except when it is desirable to fence off individual houses for several birds, or when a number of different varieties are being reared.

Fences are expensive and increase labor. To fence separate yards for the pens in Fig. 33 would require 185 rods of fence and would cost about one hundred and fifty dollars. Every time a division fence is taken out each flock has twice as much liberty as it had before. When all the division fences are removed each flock enjoys sixteen times as much as it had before. The labor of cultivating and seeding sixteen yards is much greater than it would be if all were in one field.

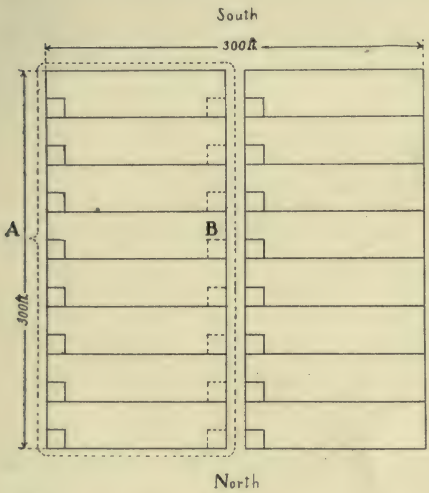

Fig. 53.—*Colony houses and yards can be arranged to save steps*

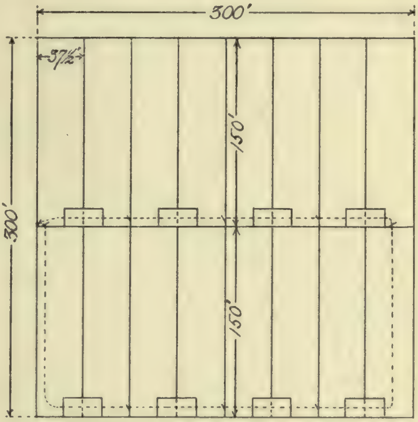

Fig. 54.—*Make yards long and narrow*

When several fowls are kept or when many small pens are desired, the plans given in Figs. 53 and 54 will save steps. If the best approach is from the north it would be better to have the house on the west at *B* instead of at *A*. The shape of the fields or strip of land or the location of the farm buildings will have much to do with the shape of the yard. If yards can be made, they should be sufficiently long and narrow to permit of easy cultivation. Two yards two rods wide and eight rods long furnish a well-shaped run for fifty hens, although more land would be better. This will allow a row of trees in the center for shade, which is necessary.

PART II. APPLICATION OF THE PRINCIPLES IN LOCATING, LAYING OUT, AND CONSTRUCTING POULTRY HOUSES

Laying out the foundation

The location of the house having been decided, find the desired height of the floor and represent this level by X. This level should be at least 5″ above the highest point on which the house will be built, except on very uneven land, when it may be advisable to excavate, grade, and build part of the floor below the original ground level. Locate a corner of the proposed building, and about this corner drive three stakes, as *a-b-c* in Fig. 55, which are approximately 3 feet apart. On each of these stakes find the level of X and connect these points by boards, as represented by *ab* and *bc*.

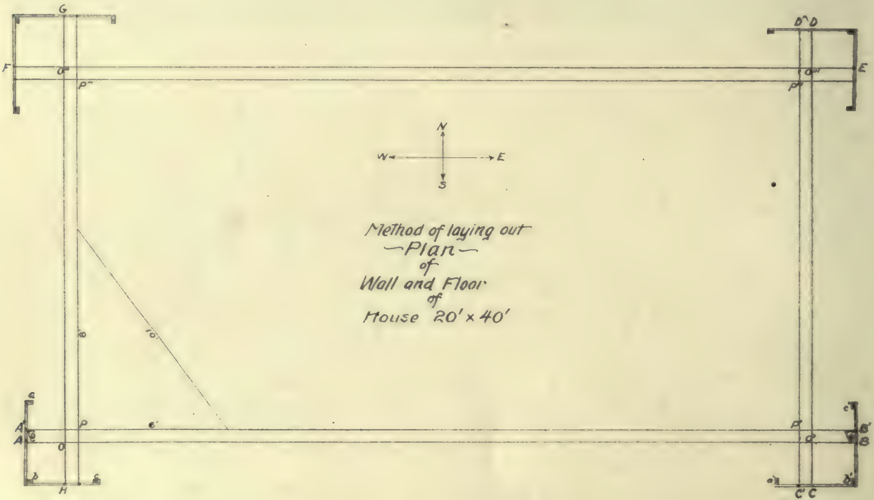

FIG. 55.—*Locating the height of the walls and floor of a poultry building*

The level of the floor can be determined either by the use of the transit, which is best for accurately laying out large buildings, or with a spirit level and straight-edge, which are equally efficient in laying out small houses. When using the level and straight-edge, drive a stake at a centrally located spot and saw off this stake at the level X (the level of the floor). Then with spirit level and one end of the straight-edge on this stake it is easy to obtain the level X on the corner stakes. When the distance between the center and corner stakes is longer than the straight edge, intermediate stakes may be driven. Each intermediate stake is made level with *X*.

From a point *A* on the cross board *ab*, a line is stretched in the direction of *B*, which is the desired frontage of the house. Measure off on this line from the point *O* the length of the desired house, and about this point *O′* fix stakes and cross boards level with *X* similar to those at the initial corner *O*. Then fasten the line *AB* at *B*. This represents the front edge of the permanent wall and floor. Next, with the square find the point *C* which, when connected with the point *O′*, makes a line at right angles with *AB*. Mark off on this projected line *CD* a distance from *O′* to *O″* equal to the desired width of the building, and about this corner *O″* place the usual level corner boards. In finding the last corner of the house mark off on a line *EF* from *O″* the length of the house, and on a line *HG* from *O* the width of the house. Swing these two lines together until the two distances intersect at the point *O‴*. Then fasten lines *EF* and *HG* at the corner boards level with *X* about the corner *O‴*.

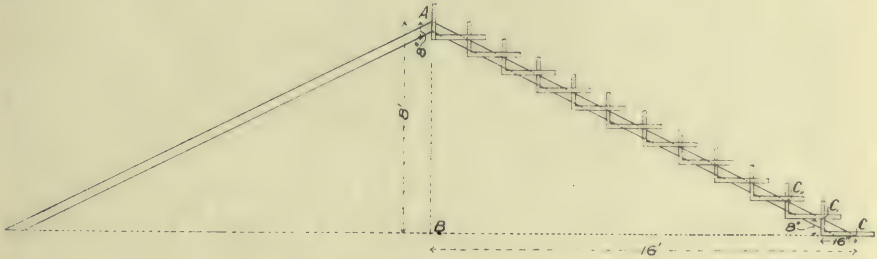

FIG. 56.—*How to mark out a rafter*

The four corners of the house are now indicated by the intersections of the four lines *AB, CD, EF,* and *GH*. These lines also represent the level of the floor and outside line of the foundation. They can be removed at any time and later replaced by simply connecting the points *A, B, C, D,* etc., on the permanent corner forms.

For indicating the width of the trench or the thickness of the wall, other lines, such as *A′B′*, *C′D′*, etc., can be made by connecting the points *A′*, *B′*, etc., which are located at an equal desired distance from *A, B,* etc.

For checking the square corners of the wall, use the 6-8-10 rule. Measure 6 feet in one direction from the corner and 8 feet in the other. If the two points thus determined are 10 feet apart the angle formed by the lines connecting the points with the corner will be a right angle.

Rafters

Fig. 56 illustrates a method of marking out a rafter for the ordinary roof. Obtain the height of the peak *A* above the plate *C*, and the distance between the plate *C* and a perpendicular dropped from the peak to point *B* on the plane with the plate. With these distances known the square can be so applied as to mark out the rafters where they should be cut to fit into place.

For example, to lay out the rafter for a building 16 feet wide, take a rafter *AC* and let the rise or distance *AB* equal 8 feet and the run or distance *BC* equal 16 feet. If an improvised square is used with a blade 16 ft. long and an arm 8 ft. long, it can be placed with one end at *A* and the other at *C*, and by sawing through the rafter on lines *AB* and *BC*, the rafter at *C* would fit on the plate and at *A* would meet a similar rafter from the other direction. The same result is obtained by placing the square on the rafter as indicated in the illustration, so that the rafter at *C* intercepts the blade of the square 16 inches from its heel, and the arm at *C* 8 inches from the heel. The square is again placed on the rafter so that the 16 inch mark covers at *C′* and the 8 inch mark at *C″*.

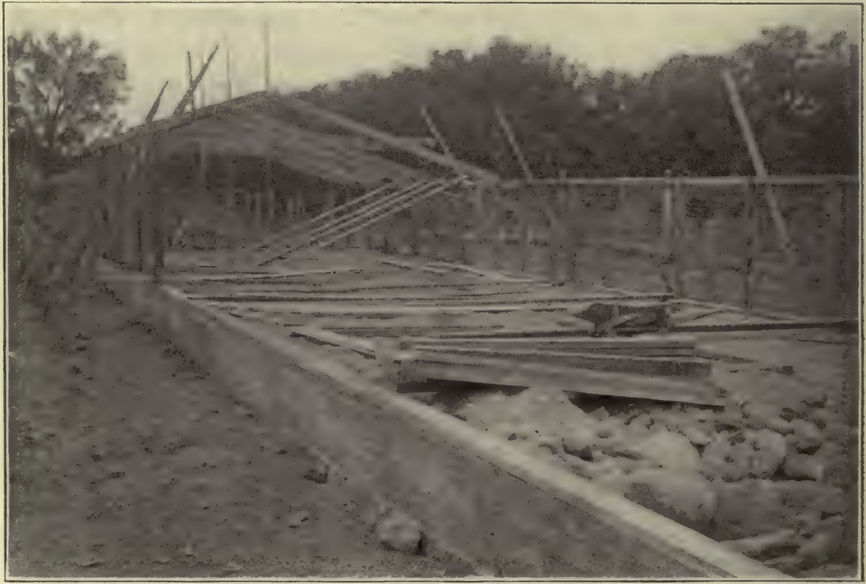

FIG. 57.—*Uneven ground should be filled in to make the floors level. The combination roof requires heavy bracing.*

If this operation is repeated 12 times, the blade of the square at the first application of the arm will mark the places for cutting the rafter to fit at the plate and the peak. Use this rafter as a guide for marking the remaining rafters.

When an eave projection is desired, draw a line the length of the rafter equidistant from its edge and lay the square to this line instead of the upper edge; then the upper part of the rafter can be left to project beyond the plate for the eaves.

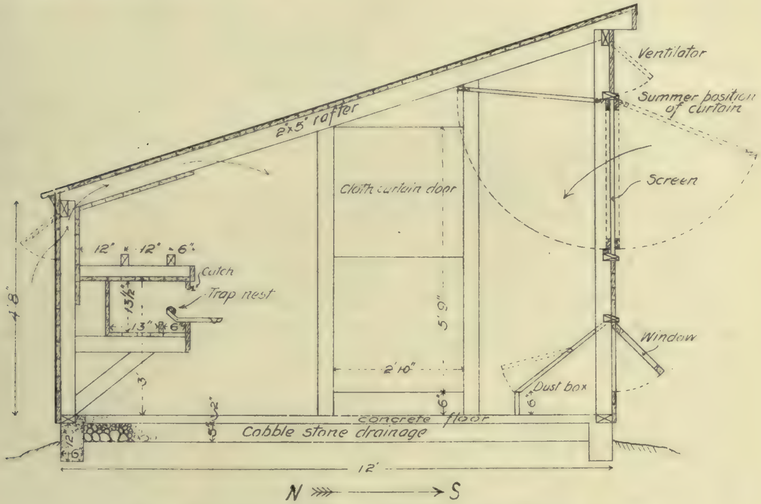

FIG. 58.—*Cross-section views of a pen 12 feet deep*

Fig. 57 shows the heavy bracing and tying of the rafters of a combination roof made necessary until the frame is covered and capable of self-support.

A shed-roof house with pens 12 feet square

It is conceded that fowls give a higher production when kept in small flocks. For this reason, in addition to the fact that many farmers and city poultry raisers have only a small number of fowls, the writers give the dimensions, illustrations and cost of a building of two pens each 12 feet square. There is frequently a demand for even smaller houses and pens. These dimensions could be reduced and the general construction of the building kept the same. See Figs. 58, 59, 60.

This style of house is one of the easiest to build. The shed roof requires no bracing and the concrete floor is sanitary. The roofing paper

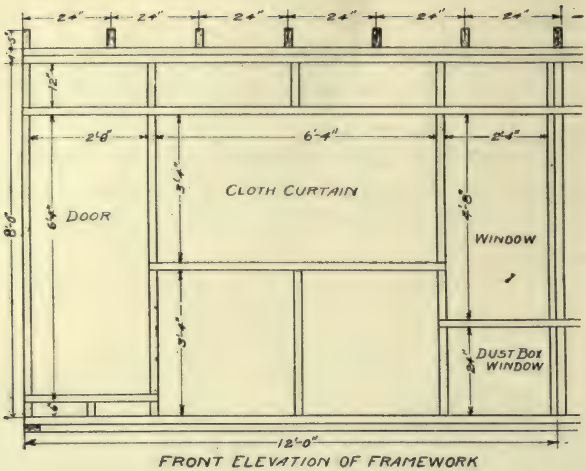

FIG. 59.—*Front view of the pen shown in Fig. 58*

on the roof and back wall makes it warm and tight. The double-boarding around the roosting chamber makes it warmer at night. The cloth curtain windows are hung inside in the winter and outside for awning in the summer. The dust box is placed directly in front of the windows with a cellar sash in front to give light and warmth and dryness.

The glass window is made up of a 6 light, 8"x10" sash fastened by strips of iron to a second 9 light 8"x10" sash. This is hinged at the side to swing back against the partition wall. Just beneath this window and directly in front of the dust box is a 2 light 12"x14" cellar sash hinged at the top to swing out and up. This makes 12 square feet of glass surface in each pen of 144 square feet floor space, or 1 square foot of glass to each 12 square feet of floor space.

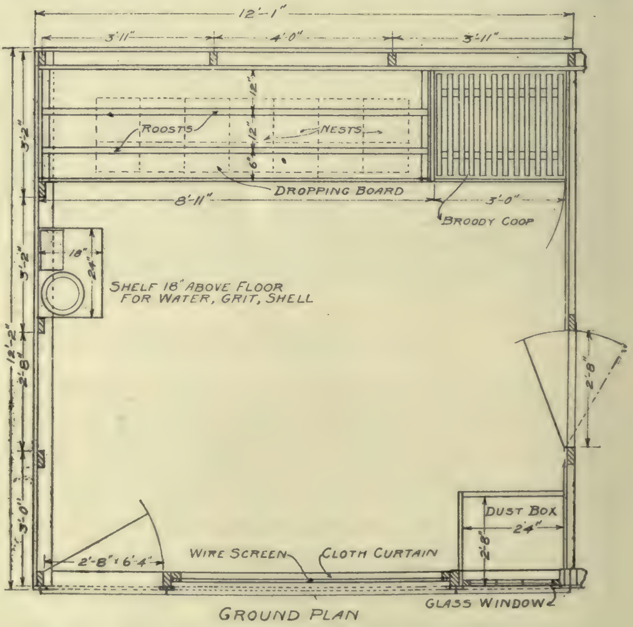

FIG. 60.—*Ground plan of pen shown in Fig. 58*

The cloth curtain, 6′4″ long and 3′4″ high, or 21 square feet in area, makes 1 square foot of cloth opening to each 7 square feet of floor area.

The materials needed at the prices common in Ithaca follow:

Materials for 12′ x 24′ house

3 cu. yds. gravel		$5.25
1½ cu. yds. sand		
18 bags cement @ 50c per bag		9.00
13 pieces 2″x4″x12′		
2 pieces 2″x4″x12′ Milled for window sills as shown in cut.		
2 pieces 2″x4″x10′		
11 pieces 2″x4″x14′		
13 pieces 2″x5″x14′		
2 pieces 1″x4″x12′		
All the above stock hemlock and surfaced four sides.	@ $25.00 per M	9.87
15 ft. 1″x12″ basswood or poplar	@ $35.00 per M	.80
15 ft. 1″x 6″ basswood or poplar		
30 sq. ft. cove siding in 12′ lengths	@ $30.00 per M	2.40
50 sq. ft. cove siding in 14′ lengths		
400 sq. ft. flooring in 12′ lengths, planed two sides, matched	@ $25.00 per M	29.45
786 sq. ft. flooring in 14′ or 16′ lengths, planed one side, matched		
2 pieces 1⅛″x4″x12′	@ $40.00 per M	5.84
2 pieces 1⅛″x4″x14′		
3 pieces 1⅛″x2″x16′		
15 pieces 1⅛″x3″x12′		
4 pieces 1⅛″x3″x10′		
6 pieces 1⅛″x1⅛″x12′		
6 pieces 1⅛″x3″x14′		
140 lin. ft. ½″x1″ window stop		
Above to be good grade white pine, planed four sides.		
2 9-light 8″x10″ glass, sash		
2 6-light 8″x10″ glass, sash		
2 2-light 12″x14″ glass (cellar sash)		
Hardware:		
3 pair 3″ lt. loose pin butts (pressed steel)		
11 pair 3″ light T hinges		
2 pair 2½″ light loose pressed steel butts		

2 pair 4″ double action spring butts		
Screws for all of the above		
2 rim night locks (2 keys)		
6 1½″ japanned iron buttons		
3 lbs. 5d nails (box)		
10 lbs. 10d nails		
10 lbs. 8d nails		
25 lbs. 20d nails		
7 ½-rolls Neponset		
2 gal. No. 6 17 paint (De Voe's)	$24.35	
Total cost of materials		$86.96
Labor, estimated at ⅓ material cost		28.98
Cost of labor and materials		$115.94
Cost per fowl, allowing 4 sq. ft. per fowl		1.61

A medium-sized pen sixteen feet square

The pen of moderate size is very popular among poultrymen who keep several hundred fowls. It is more economical in construction and in saving of labor than the smaller pen.

A house 16 feet deep can be built with the shed type of roof. It is inadvisable to build wider than 16′ with this style, since such a roof requires extra bracing and the front would soon reach an undesirable height unless the roof were made very flat or the rear wall very low. Figs. 61, 62, 63 show the 16′ x 16′ shed type of pen. Fig. 61 shows the roosts fastened together with a 2″x2″ cross stick which is hinged at the back wall end, to swing up and fasten while the droppings board is being cleaned. It also has an alleyway form of nest which the fowls enter from the ends as represented in Fig. 63. With slide doors covering these entrances the broody hens or young pullets can be kept from roosting in the nests. The eggs are gathered from the front by dropping a hinged door. The hoppers for ground grains, grit and shell and the water pans are placed on platforms eighteen inches to two feet above the floor to keep them free from litter when the fowls are working below.

There are two windows shown in this plan and both are near the center of the front. This gives the best light and allows the windows to swing entirely around to the wall. The glass windows are placed with the bottom one foot and the top seven feet above the floor. Each window is made and hung in the form of a door by fastening together three 6-light 8″x10″ sash. This makes a total of 20 square feet of total glass surface

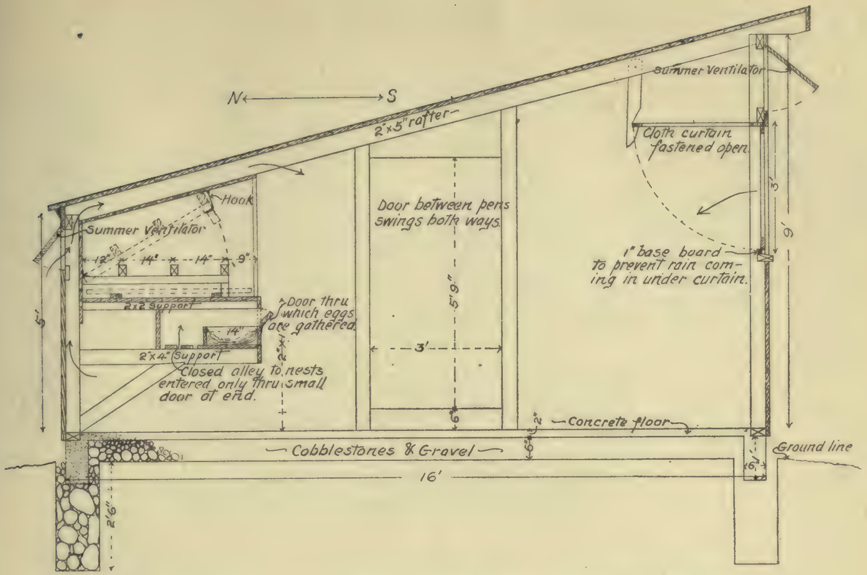
N ← → S
2"x5" rafter
Hook
Summer Ventilator
12"
14"
14"
9"
2x2 Support
14"
2"x4" Support
Door thru which eggs are gathered
2'-1"
Closed alley to nests entered only thru small door at end.
5'
Door between pens swings both ways.
5'9"
3'
6"
Summer Ventilator
Cloth curtain fastened open.
3'
9'
1" base board to prevent rain coming in under curtain.
2"
Concrete floor
6"
Cobblestones & Gravel
16'
Ground line
1'
6"
2'6"

Fig. 61.—*A cross-section working plan of a pen 16 feet deep*

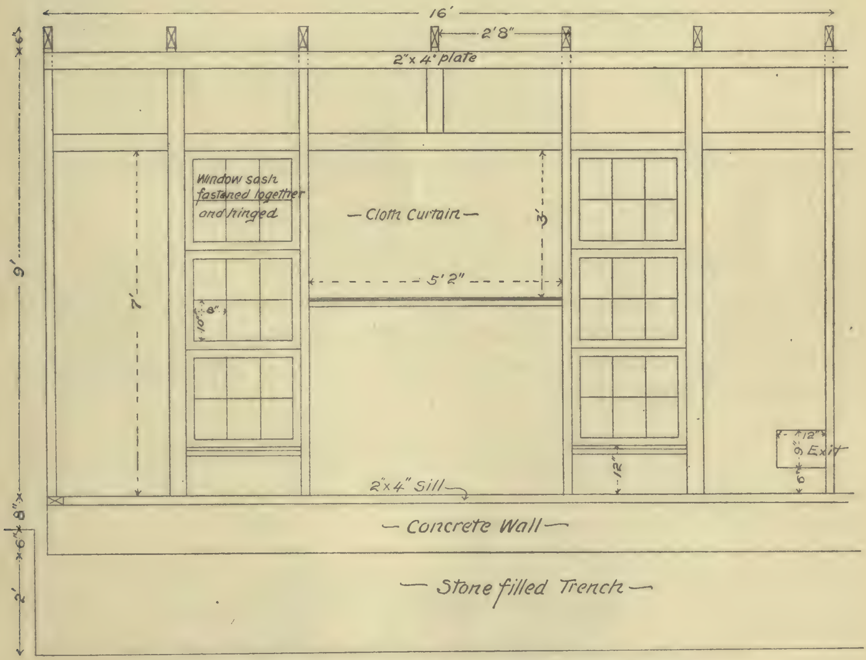

Fig. 62.—*Front elevation of a house with pens 16 feet square*

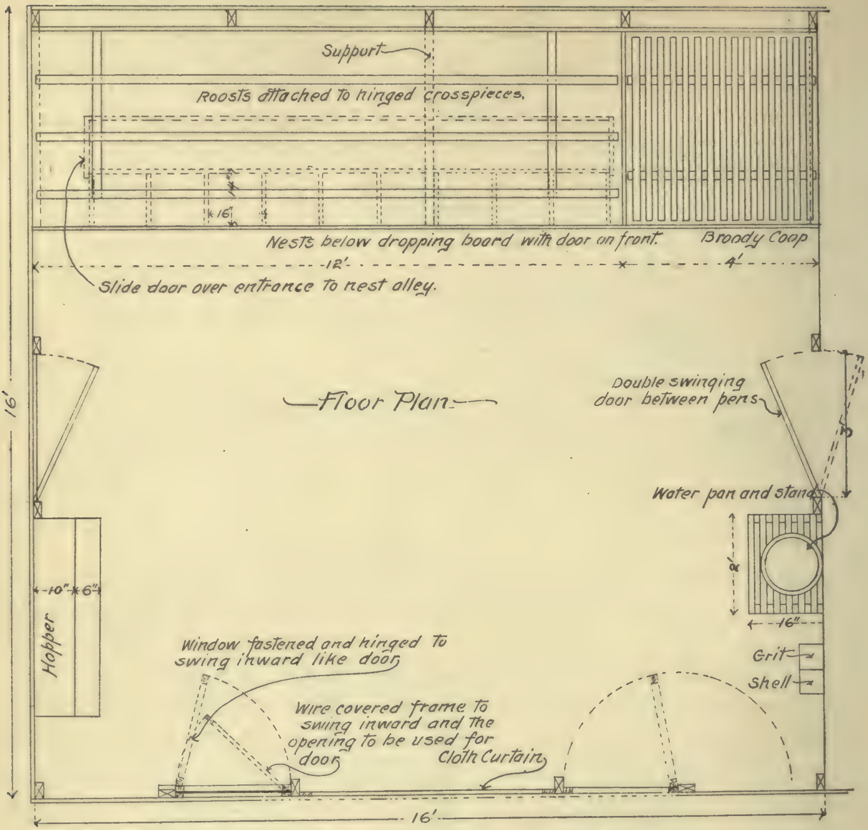
Support
Roosts attached to hinged crosspieces.
16"
Nests below dropping board with door on front.
Broody Coop
12'
4'
Slide door over entrance to nest alley.
16'
Floor Plan
Double swinging door between pens
Water pan and stand
8"
16"
Grit
Shell
10"
6"
Hopper
Window fastened and hinged to swing inward like door
Wire covered frame to swing inward and the opening to be used for door
Cloth Curtain
16'

FIG. 63.—*Interior arrangement of a pen 16 feet square*

or 1 square foot of glass to every 12.8 square foot of floor surface. The cloth curtain 5′ 2″ x 3′ gives a cloth area of 15.5 square feet, or 1 square foot of cloth to every 16.5 square foot floor surface.

The materials needed in the construction of a house of this type and their cost and labor follow:

Materials for a house 16′ x 32′

15 sticks 2″x4″x16′
15 sticks 2″x4″x14′
6 sticks 2″x3″x12′
13 sticks 2″x5″x18′
2 sticks 2″x4″x12′ Milled for window sills as shown in Fig. 58
Hemlock or S. pine, surfaced four sides
@ $25.00 per M.......................... $13.70

405 sq. ft. matched, planed stuff for roof, 18′ lengths	@ $25.00 per M		$53.40
360 sq. ft. matched, planed stuff for roof, 16′ lengths			
220 sq. ft. matched stuff for back, 12′ lengths			
300 sq. ft. matched stuff for ends, 16′ lengths			
150 sq. ft. matched stuff for partition, 16′ lengths			
700 sq. ft. matched stuff for misc., 16′ lengths			
280 sq. ft. matched cove siding for front, 12′ lengths @ $35.00 per M			9.80
12 pieces 1½″ planed stuff for broody coop, 12′ lengths	@ $40		2.72
12 pieces ⅞″x3″ planed for battens, etc., 12′ lengths			
6 pieces ⅞″x⅞″ planed for 16′ lengths			
2 pieces ⅞″x2″ planed for battens, etc., 12′ lengths			
2 pieces wedge-shaped moulding, 16′ lengths			
5 cu. yds. gravel			8.75
2½ cu. yds. sand			
28 bags cement for concrete floor and wall, using one part cement, three parts sand and six parts gravel			14.00
Gravel and cobblestones for filling in (extra)			
12 6-light 8″x10″ sash, 65c each		$7.80	
Hardware:			
8 pair 3″ light hinges, 7c pair		$ .56	
8 pair 3″ T hinges, 7c. pair		.56	
3 pair 5″ heavy strap hinges, 12c. pair		.36	
1 pair 4″ double acting hinges, 35c. pair		.35	
12 1½″ japanned iron buttons, 2c. each		.24	
1 door latch and lock		.20	
8 lbs. 5d nails (box), 3c. per lb		.24	
40 lbs. 8d nails, 3c. per lb		1.20	
25 lbs. 20d nails, 3c. per lb		.75	
3 gal. paint, $1.60 per gal		4.80	
4 yds. muslin, 5c. per yd		.20	
7 rolls roofing paper, $3.00 per roll		21.00	
			$38.26
Total			$140.63
Cost labor at one-third cost of materials			46.88
			$187.51
Cost per fowl @ 4 sq. ft. per fowl			$1.46

A continuous house 20 feet wide

Recently there has been a strong and constant tendency on the part of the large commercial poultry raisers to build long houses with pens large enough to accommodate 100 to 500 fowls. This practice is justified principally because of economy in labor required in caring for the fowls, and in the original cost of the building.

A long house makes it possible to use labor-saving devices such as trolley system, large hopper feeding and running-water devices, which not only expedite work but also lighten the task. A trolley system can be used for all feeding, for carrying eggs, for cleaning pens, or even for carrying water when running water is not possible. This style of house allows large numbers of fowls to be easily accessible. The work can be done comfortably during inclement weather.

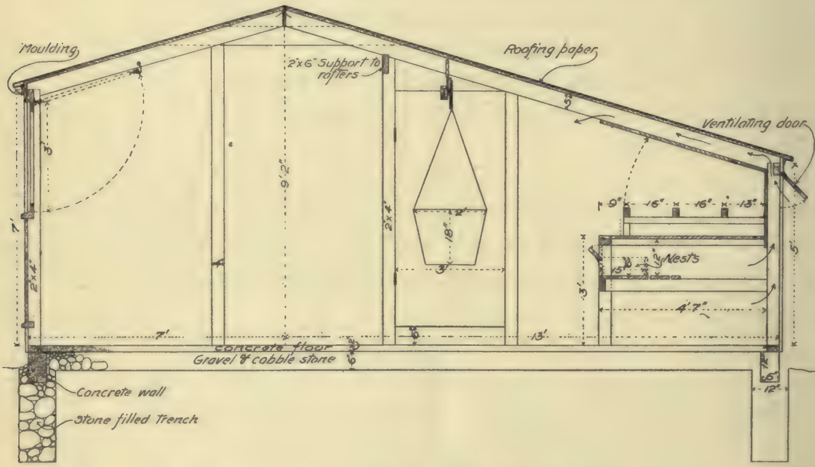

FIG. 64.—*Cross-section of a pen 20 feet deep*

The building shown in Figs. 64, 65, 66 is 20 feet deep and 110 feet long. It is divided into five pens each 20 feet square and one feed room at the east end 10 x 20 feet. The front of each pen is fitted with two glass windows made up of two 6-light 10"x12" and one 3-light 10"x12" sash. This makes exactly one square foot of glass surface to every 16 square feet of floor space.

The glass windows are placed 8 inches above the floor and to the plate 6 feet higher. By bolting the three sash together with pieces of strap iron, the windows can be hinged at the side and used both for summer ventilation and as doors. When used as doors, the wire screen must be put on a frame so that it also may be opened, as represented in Fig. 66.

In addition to the glass there are two muslin curtains each 3 feet high and 5 feet long, making 1 square foot of cloth surface to every 26.6 square foot of floor. The cloth windows are hinged at the top to swing in and fasten open as shown in Fig. 64, it being customary to keep them open the greater part of the day. The opening is well above the floor.

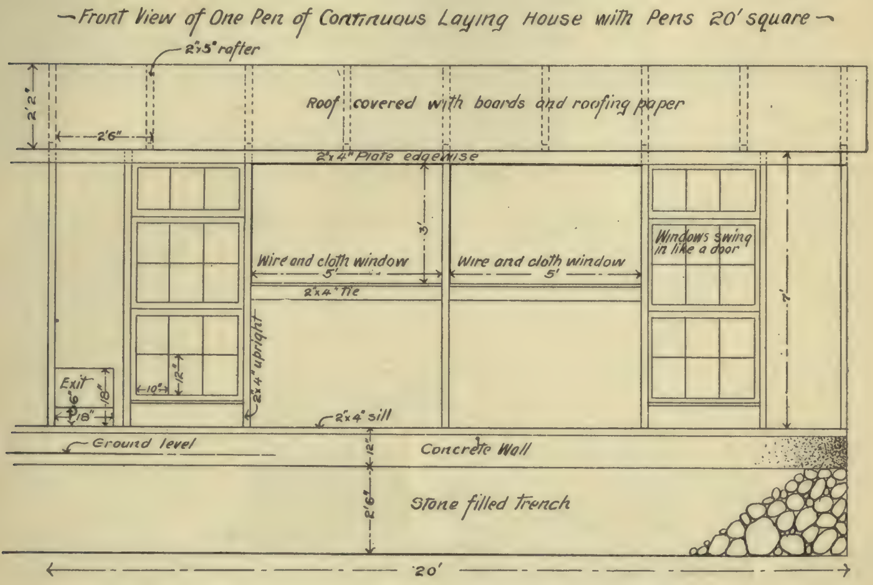

FIG. 65.—*Front view of 20′ pen shown in Fig. 51*

This prevents a draft blowing directly on the fowls. With this type of open-front house it is of prime importance to construct the remaining sides of the pen tight, thus preventing any possible draft. These conditions allow the least possible draft, but at the same time provide an abundance of pure, fresh air so vital to the comfort and health of the fowls.

A house of this width is not usually covered with a shed roof, which would give it a somewhat ungainly appearance, but rather with a combination or a half-monitor roof. The combination roof especially gives the building a symmetrical appearance not to be obtained with the shed nor even with the low gable roof.

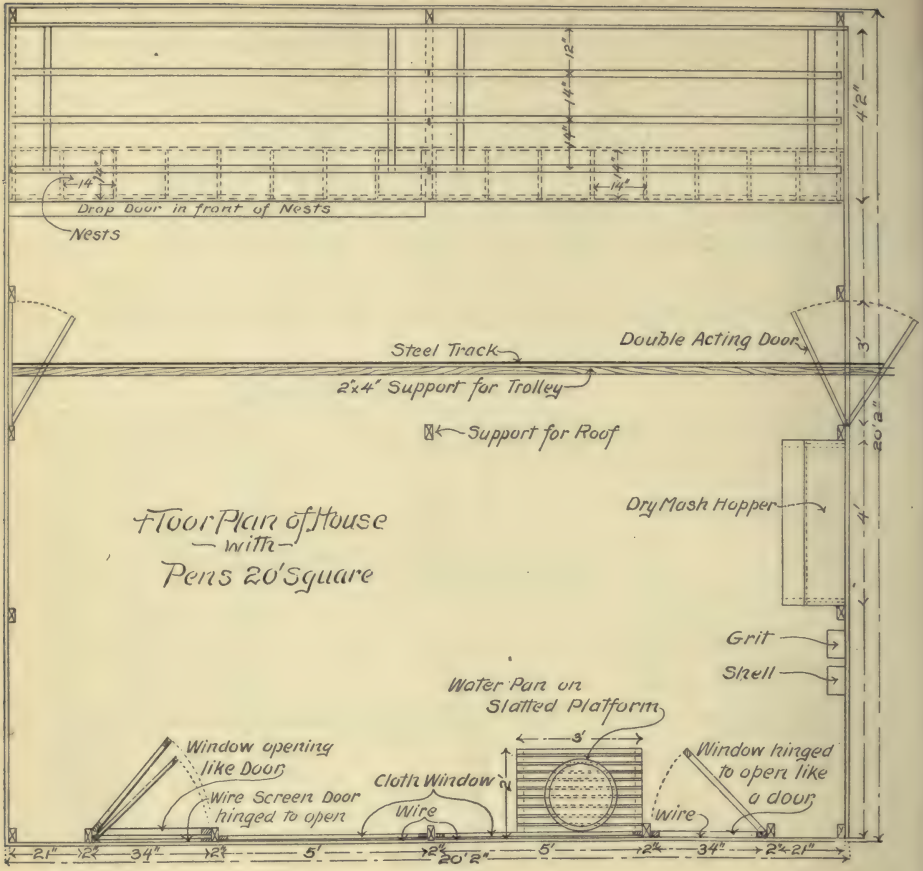

Fig. 66.—*Floor plan of 20' house shown in Fig. 51*

The materials needed in the construction of a house of this type and their cost and labor follow. The cost is based on the prices paid for materials in the construction of the house illustrated in Fig. 51.

Materials for a 20' x 110' house

112 pieces 2"x4"x10'
28 pieces 2"x4"x14'
16 pieces 2"x4"x12'
23 pieces 2"x5"x16'
45 pieces 2"x5"x14'
11 pieces 2"x8"x10'

30	pieces 2″x3″x10′	
10	pieces 2″x2″x12′	
10	pieces ⅞″x3″x10′ window frames	
13	pieces ⅞″x3″x12′	
5	pieces ⅞″x⅞″x16′ butts	$60.40
3,052	sq. ft. for roof, any lengths	
962	sq. ft. for ceiling, any lengths	
731	sq. ft. for back in 16′ lengths	
1,095	sq. ft. for drop boards and nests, 10′ lengths	
831	sq. ft. for partitions, in 10′ and 14′ lengths	
375	sq. ft. for ends, in 14′ and 16′ lengths	
520	sq. ft. for front, in 16′ lengths	
244	sq. ft. for misc., in 16′ lengths	
	One-fourth has been added for matching	152.29
26	rolls 1-ply rubberoid roofing	41.60
150	lbs. 8d nails	
40	lbs. 20d nails	
15	lbs. 5d nails	
110	ft. barn door track	
2	roller bearing barn door rollers	
1	rim lock	
1	door latch	
5	pair double swinging spring hinges	
2	pair 5″ heavy strap hinges	
65	pair 3″ strap hinges	
12	track hangers	
3	doz. hooks and eyes	
3	doz. buttons	
2	doz. handles	
1	doz. cupboard latches	
120	ft. fine mesh poultry wire, 3 ft. wide	
5	gal. paint, two coats	
44	short strips of wagon tire to fasten sash together	
	Hardware	47.00
11	3-light 10″x12″ cellar sash	19.80
22	6-light 10″x12″ sash	
50	ft. muslin cloth 3′ wide	1.15

100 bags cement	$37.50
40 yds. gravel and sand mixed and drawn	24.50
Material cost	$384.24
Labor and team cost	182.75
Total materials and labor	$566.99
Cost per fowl (4 sq. ft.), exclusive of feed room	$1.13
Cost per fowl (4 sq. ft.), inclusive of feed room	1.03

The irregularity of the ground on which this building was put made necessary the unusually deep foundation illustrated in Fig. 57. Deducting $50.00 for the extra labor and material used in this construction, bringing it down to the same floor depth as used in the other houses, makes the actual cost of materials and labor for this building $516.80, or $1.03 per fowl allowing 4 square feet floor space per fowl, exclusive of the feed room, and only 94 cents per fowl at 4 square feet per fowl including the entire floor area. The larger size of this building made it possible to purchase materials in quantities which would obtain a discount.

It is at once noticed that the type of construction varies in the different houses. Part of these alterations are presented to show the adaptability of different forms of nests, ventilators, etc. Not one of them is most desirable in every instance. It is impossible to construct any building which embodies every desirable feature. To obtain the best construction in one respect often necessitates the compromising of another part. This is illustrated in Fig. 62 in which two glass windows are desired as near the center of the front as possible. This makes a smaller cloth opening than in either of the other two buildings. To get the same comparative size of cloth as in the others would necessitate moving the windows to the extreme sides of the house, which would not give the best light nor present as attractive an appearance.

CONCLUSION

In this bulletin it is not the intention to lay down hard and fast rules to be rigidly followed. Each reader is left to apply the principles to his own particular conditions. The three plans for houses here presented should meet satisfactorily a variety of uses in New York State. For special purposes other types of houses will be desired. It is expected that persons who build from these plans, while adhering in the main to the general principles discussed, will make modifications which may prove distinct improvements. From all who build according to these plans in full or in part, the authors will be glad to know the results.

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 130. SEPTEMBER, 1910

Construction of a Modern Poultry House and Report of Experiments in Hopper Feeding Laying Hens

By HORACE ATWOOD

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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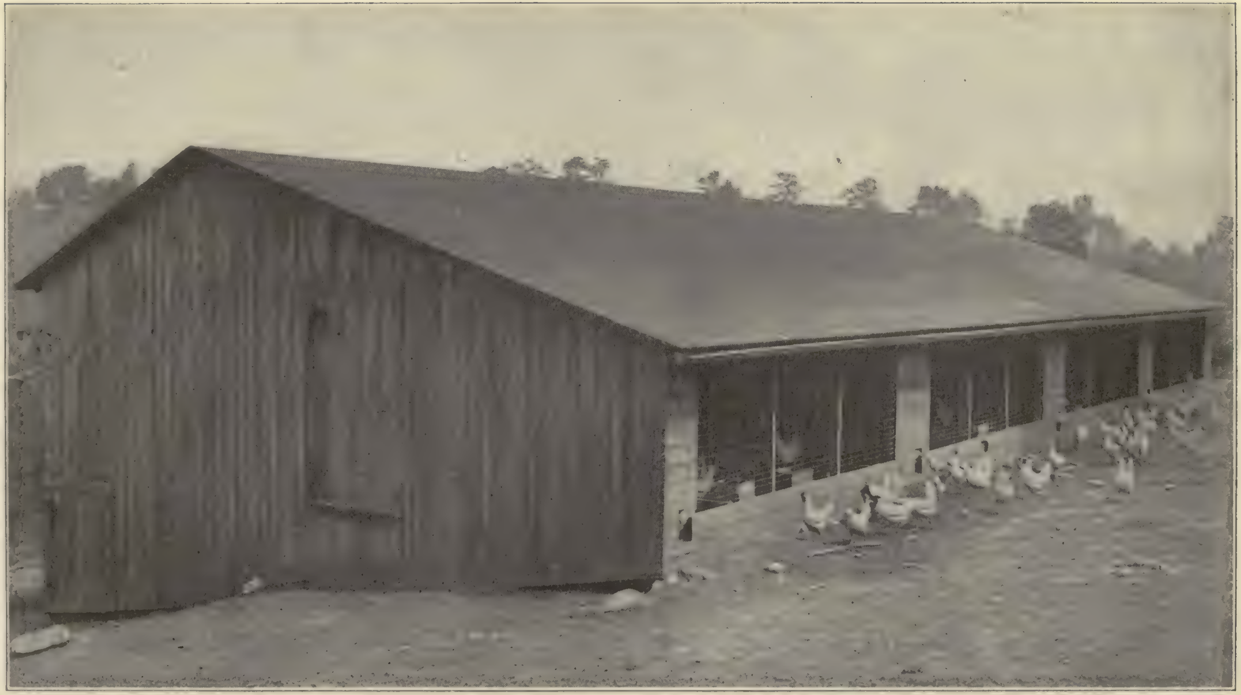


OPEN FRONT LAYING HOUSE

Experiments in Hopper Feeding Laying Hens

In the production of eggs the main items of expense are for the food required by the fowls; for labor to care for them; for repairs to the buildings and equipment; and for systematically replacing each year the older individuals with younger and more productive birds. The amount and the cost of food required by a fowl in the course of a year has been set forth in former bulletins of this Station.

The cost of labor to care for a fowl for a year depends upon several factors among which may be mentioned the number of fowls kept, the manner in which they are housed, fed and watered, and the facilities for cleaning and keeping the houses in a sanitary condition, and free from lice and mites. As no two poultry houses are the same in all respects it is quite probable that the labor cost of caring for fowls varies widely in different sections of the country and under different conditions.

In an address delivered before the American Poultry Association it was stated that on a certain poultry plant in Maine where two thousand hens are kept in a long laying house the labor cost is thirty-six cents per hen per year. This did not cover the cost of removing the soiled litter, and replacing it with straw or other scratching material.

In this particular instance the cost of labor per fowl, per year, was apparently about one-third as much as the cost of food. On many other egg farms where the arrangements are not so convenient as in the case mentioned it is entirely probable that the labor cost for caring for fowls may amount to one-half as much as the cost for food or perhaps even more.

In practice it is just as important to economize in respect to the cost of labor as it is to increase the egg yield by skillful feeding or breeding, as in both cases the object is to lower the cost of production.

Is there any way of feeding fowls which requires little time and attention and yet which gives good results with respect to egg yield?

HOPPER FEEDING.

On many farms it has been the custom in the past to feed once per day a mash composed of ground grain, beef scrap, etc., moistened with water. Moistening the ground feed and placing it in troughs for the fowls requires considerable time. Experience and good judgment are also required in order to feed just the proper amount. If too much mash is fed the excess is usually wasted, and if not enough is supplied the egg production is restricted to that extent.

In the hopper system of feeding, the grain or dry mash is placed in suitable receptacles so that the fowls can help themselves at will. This materially reduces the cost of labor in feeding the fowls, but do they lay as well? The experiment described below has been performed for the purpose of beginning the study of this subject.

The experiment began December 8th, 1905, with four lots of fowls each consisting of twenty single comb White Leghorn pullets. On January 17, 1906, another pen of twenty White Leghorn pullets was added to the test and the record of this pen also is given. The pullets added to the test in January were hatched later in the season than those in the other four pens and were practically of the same age and weight when added to the test as the other pullets were at the beginning, and it is believed that the results derived from all five pens are to a certain extent comparable. The test was continued for one year.

The method of feeding each pen was as follows:

Pen 1. This lot of fowls was fed shelled corn, beef scrap, and wheat bran, in hoppers constructed so that there was a supply of these feeding stuffs constantly before them. The general health of these fowls was apparently good, although the mortality was heavy, four dying in the course of the year. Those which died were fat and heavy and probably the cause of death was enlargement of the liver.

Pen 2. This pen was hopper fed with corn, beef scrap, and a mixture of equal parts by weight of corn meal, wheat bran, and ground oats. For the first month the corn, beef scrap and ground feed was supplied ad libitum, but as the egg production was very unsatisfactory with a supply of corn constantly before the fowls, the practice was adopted for the remainder of the year of closing the corn orifice early in the morning and opening it again at night when picking up eggs. The fowls in this pen, then, had access to beef scrap and ground grain during the day, and to shelled corn for a short time at night and morning. Three hens died in this pen, one from prolapsus of the oviduct, one was crop bound and the other died from some undetermined cause.

Pen 3. This pen was hopper-fed with (1) a mixture of equal parts by weight of corn, wheat, and oats; (2) beef scrap; and (3) a mixture of equal parts by weight of corn meal, ground oats and wheat bran. As the corn, wheat and oats were mixed together it was thought that it would be possible to make the fowls eat the oats as well as the wheat and corn. It was found in practice, however, that after the oats had accumulted to a certain extent in the trough of the self-feeder they were thrown out by the fowls and some unavoidably wasted, thus making the recorded food consumption for this pen abnormally high. There was no mortality.

Pen 4. This pen of fowls was fed a moistened mash in the morning consisting of a mixture of corn meal, wheat bran, ground oats and beef scrap. Toward evening a mixture of whole grain was scattered in the litter covering the floor of the house. There were no deaths.

Pen 9. This flock was hopper fed with a mixture of equal parts by weight of corn meal, wheat bran and ground oats. In another compartment of the hopper beef scrap was supplied. Once per day a mixture of whole grain was scattered about in the litter so as to induce the hens to take exercise. Two hens died, the cause of death was not determined.

The fowls in this test were confined to the houses and runs described in former bulletins, the houses being about ten feet wide and twenty feet long and the runs about thirty feet wide by a hundred feet long. No green food was supplied them in winter, but in summer a fair quantity of green stuff grew in the runs but the supply toward fall became limited. In all cases the food was weighed out carefully in bulk for each pen by the Assistant Agriculturist but the actual feeding was intrusted to a farm laborer.

The following table shows the average weight of the hens at the beginning, and end of the test; on May 21st; and on August 25th.

TABLE SHOWING WEIGHT OF FOWLS.

	1905	1906				1907
Pen.	Dec. 8	Jan. 17	May 21	Aug.25	Dec. 8	Jan..17
1......	3.50		3.32	3.12	3.70	
2......	3.48		3.30	3.45	4.00	
3......	3.45		3.22	3.15	3.85	
4......	3.50		3.12	3.10	3.77	
9......		3.52	2.98	3.00		3.77

During May and August the fowls were not so heavy as at the beginning of the test. At the close of the year, however, all of the fowls were somewhat heavier than at the beginning.

The following table shows the amount and kind of food consumed by the various pens of fowls during the year:

POUNDS FOOD CONSUMED.

Pen	Corn	Wheat	Oats	Corn Meal	Wheat Bran	Ground Oats	Beef Scrap	Total
1.......	1024.3				115		50	1189.3
2.......	865			142	142	142	91	1382
3.......	385	375	375	102	102	102	79	1520
4.......	288	288	288	145	145	145	90	1389
9.......	276	276	258	142	148	144	148	1392

The table shows the pens 2, 4 and 9 consumed almost exactly the same amount of food, or in round numbers practically seventy pounds per fowl. The food consumption of pen 1 was slightly less than in the case of pens 2, 4 and 9, and pen 3 stands higher, probably due to wastage as already noted.

The following schedule of prices has been used in calculating the cost of feed consumed by the fowls. These prices represent as accurately as could be determined the average retail prices which prevailed in Morgantown during the year covered by the test.

Corn $1.08 per hundred.

Wheat $1.50 per hundred.

Oats $1.40 per hundred.

Corn Meal $1.25 per hundred.

Wheat bran $1.25 per hundred.

Ground oats $1.50 per hundred.

Beef scrap $2.25 per hundred.

The following table gives the cost of the food consumed by the experimental pens during the year.

COST OF FOOD.

Pen	Corn	Wheat	Oats	Corn Meal	Wheat Bran	Ground Oats	Beef Scrap	Total
1......	$11.06				1.44		1.12	13.62
2......	9.34			1.77	1.77	2.13	2.04	17.05
3......	4.15	5.62	5.25	1.27	1.27	1.53	1.78	20.87
4......	3.11	4.32	4.03	1.81	1.81	2.17	2.02	19.27
9......	2.98	4.14	3.61	1.77	1.85	2.16	3.33	19.84

The table shows that pen 1, fed principally upon corn, was fed for the least money. Next in order stands pen 2, followed in turn by pens 4, 9 and 3. The total cost of food for the year for the hundred fowls which were in this test was $90.65, or slightly more than ninety cents per fowl.

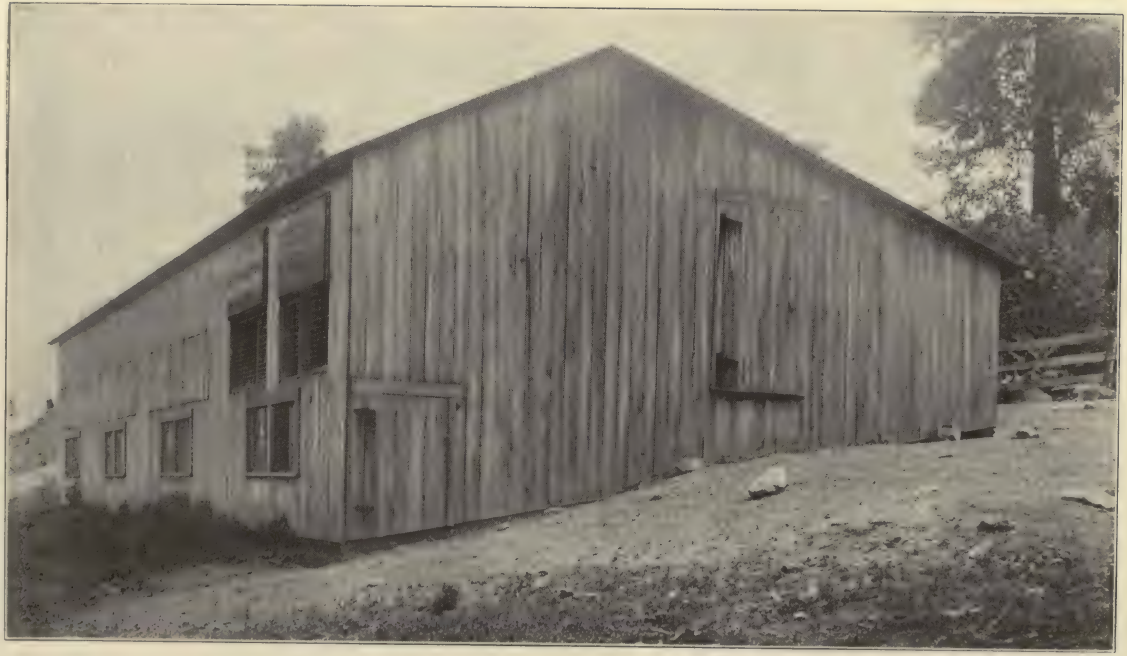
The following table shows the egg production by months for the different lots of fowls:

	Pen 1	Pen 2	Pen 3	Pen 4	Pen 9
1905					
Dec. 8	71	46	80	118	...
1906					(Jan. 17)
Jan.	61	138	37	140	69
Feb.	152	199	139	149	232
Mar.	288	398	357	390	406
Apr.	258	357	300	334	332
May	202	295	300	300	323
June	205	299	286	287	299
July	169	278	238	253	323
Aug.	141	227	220	195	241
Sept.	36	99	86	57	172
Oct.	14	23	20	21	52
Nov.	24	32	13	68	...
Dec.	7	16	24	21	27
1907					
Jan. 17	...	...	...	...	19
Total	1628	2407	2100	2333	2495

The egg production was not especially heavy with any of the pens of fowls. The best record was made by pen 9, which was hopper fed with mash and beef scrap, and with whole grain once per day scattered in deep litter. Next in order stands pen 2, which had access to corn in a hopper for a short time in the morning and evening. Materially behind all of the other pens, and with a remarkably low egg record, is pen 1, which received corn, beef scrap and wheat bran ad libitum.

The following table shows the average food cost of the eggs per dozen and the cost of food per hen per year.

	Cost of eggs.	Cost of food per hen per year.
Pen 1	10 cts. per doz.	68 cts.
Pen 2	8.5 cts. per doz.	85 cts.
Pen 3	11.9 cts. per doz.	104 cts.
Pen 4	9.9 cts. per doz.	96 cts.
Pen 9	9.5 cts. per doz.	99 cts.



END AND REAR VIEW, SHOWING TWO OF THE VENTILATING SHUTTERS OPEN

The table shows that the food cost of the eggs produced by the different pens during the year varied from 8.5 cents to 11.9 cents per dozen. Pen 2 leads in respect to low cost of eggs, while pen 1 leads in respect to the cheapness of the ration. The hopper fed pens, 2 and 9, produced eggs having a lower food cost, and those laid by pen 1 cost only slightly more, than those laid by pen 4 which received moistened mash.

SUMMARY.

1st. In a year's test with five pens of fowls the cost of food varied from eighty-five cents to one dollar and four cents per fowl per year, and averaged ninety cents per fowl for the one hundred fowls in the experiment.

2nd. The egg production varied from 81.4 eggs per hen in the case of pen 1, fed principally upon corn, to 124.7 in the case of pen 9, which received whole grain once per day, scattered in litter, and dry mash and beef scrap ad libitum in a hopper.

3rd. The food cost of the eggs during the year varied from 8.5 cents to 11.9 cents per dozen.

4th. Two pens, hopper fed, produced eggs having a lower food cost than the pen which received moistened mash, and in this test there was apparently no benefit from the extra labor involved in moistening the mash.

AN OPEN FRONT LAYING HOUSE.

In Bulletin No. 115 of this Station is given a description, together with working drawings of the curtain front laying house which was erected on the Station farm some years ago. This house has continued to give satisfaction in respect to the comfort and health of the fowls. It has been found, however, that the double wall on the north side of the house is an excellent harbor for rats and this method of construction should be avoided in building poultry houses. Recently another house has been erected of a different type, and as it also seems to be well adapted to West Virginia conditions a description of it should be of interest to West Virginia poultrymen.

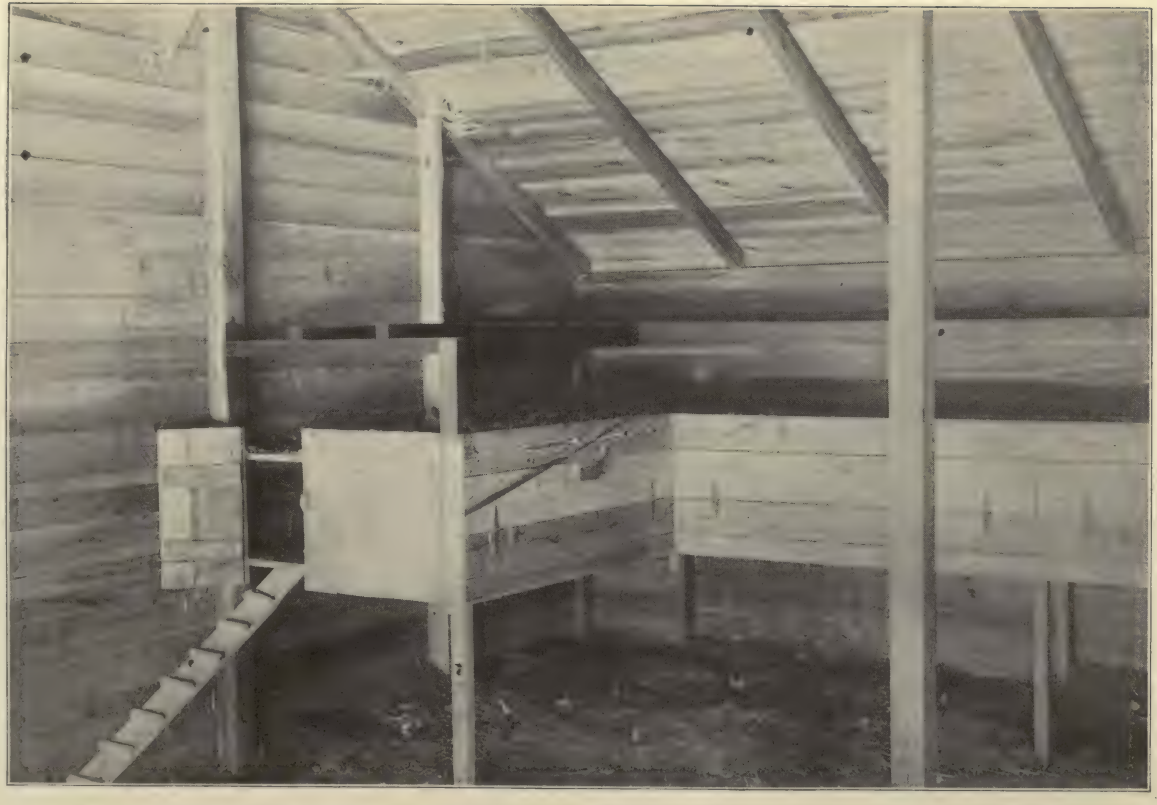
The house under discussion is of the open front or Tolman style, and is characterized by having the front completely open or covered only with wire netting in order to keep out stray animals or vermin. The house is twenty-four feet wide and sixty-four feet long and is divided by solid board partitions into four sections, or rooms, each sixteen feet wide and twenty-four feet long. The house is five feet high in front and six above the basement or scratching room in the rear. The roof is of unequal span, the peak being located two thirds of the distance from the front to the rear, and having an elevation above the floor of ten and one-half feet.

Being located on sloping ground, the house was provided with a scratching shed underneath. This portion is about four feet high with a dirt floor and the fowls gain access to it through trap doors placed in each section. This provides a place for the fowls to dust themselves and exercise in winter and is a very desirable feature.

The perches are on a level with the front opening. In winter when the fowls have gone to roost the warm air resulting from their presence tends to collect in the upper portion of the house maintaining a comfortable temperature even in severe weather. Last winter with its zero temperatures the combs of S. C. White Leghorn hens were not frozen even when the front of the house remained constantly open. In poultry houses having a shed roof the warm air constantly flows away from the fowls, when they are on the perches, thus making the shed roof type of house somewhat colder for the fowls at night.

In order to keep the house cool during the warm season two doors are provided in the rear wall of each section of the building, opening underneath the nest boxes. When these doors are open, as in summer, the wind has unobstructed passage through the house and the fowls when on the perches remain comfortable even on very sultry nights.

This house has been in use for a year and seems to be well



INTERIOR VIEW SHOWING OPENING TO NEST BOXES UNDERNEATH THE PERCHES adapted to West Virginia conditions. It should face the south or southeast, and if a wind break is provided opposite the open side so much the better.

One of the advantages of this house is that the fowls always have plenty of fresh air and consequently remain healthier than where they are compelled to breathe impure air too often found in poultry houses. The free circulation of air too prevents any condensation of moisture on the walls of the building during frosty weather, and the litter on the floor constantly remains crisp and dry. Fowls remain healthier in a cold dry house than in a warm damp one.

The house was built by contract and cost $450, complete. Four hundred Leghorns can be housed comfortably in it.

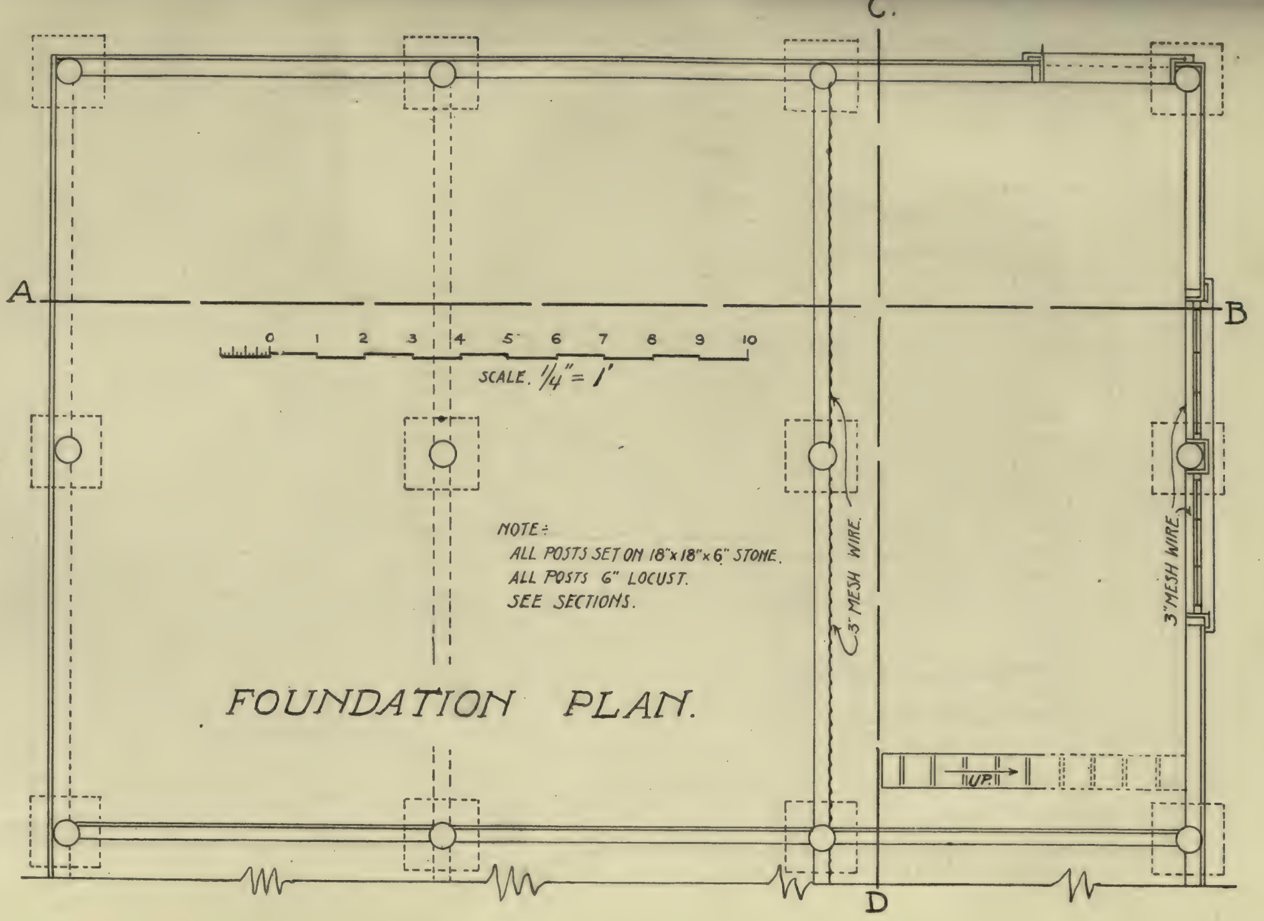
The cuts drawn to scale show the details of construction, and the bill of material for one section of the house including both sides is appended hereto. If two or more sections are constructed multiply the amount of material required for one section by the number of sections, and deduct the amount of ceiling to board up one side.

BILL OF MATERIALS FOR MODEL POULTRY HOUSE.

ONE SECTION ONLY, 24′x16′.

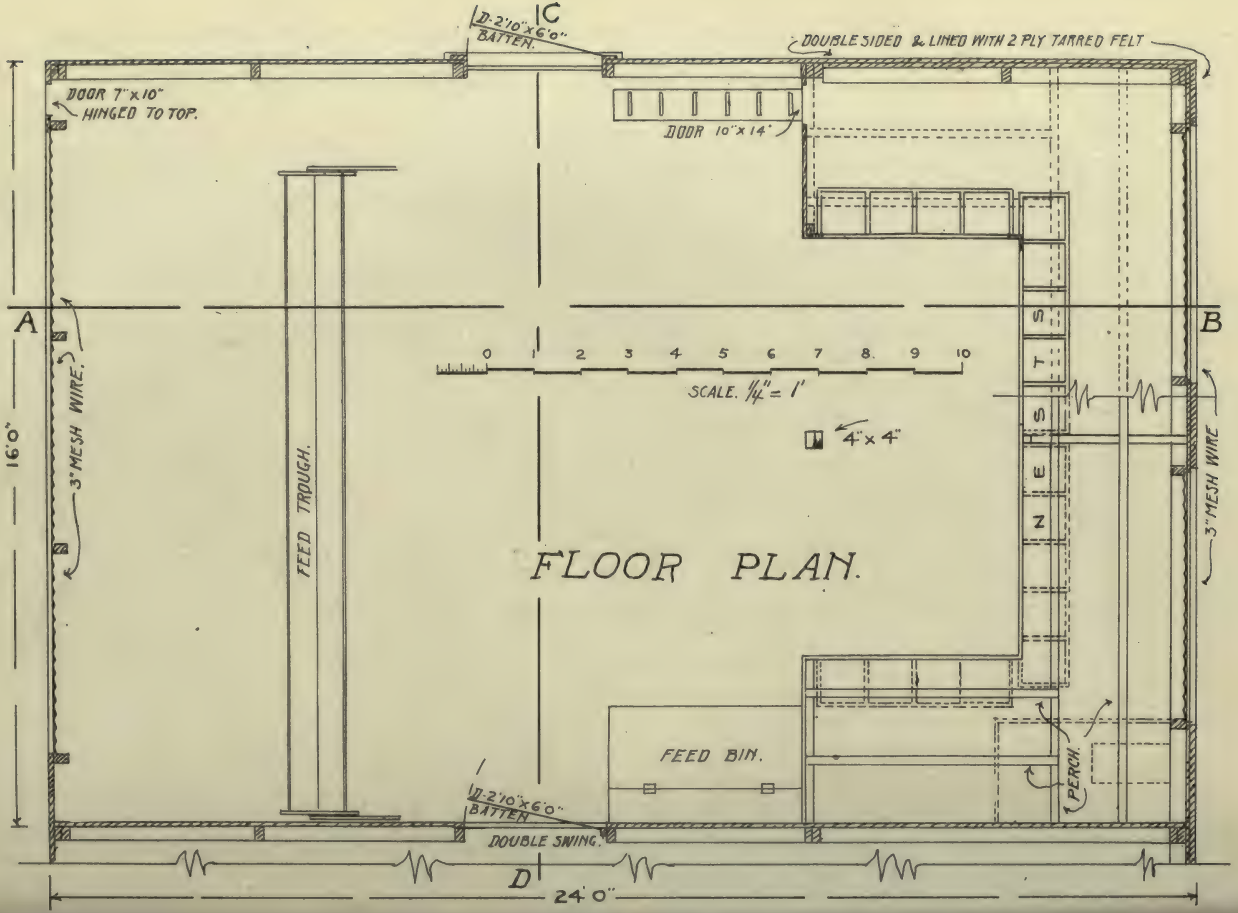
6 pcs. posts, 6″x2′ 6″ locust.
3 pcs. posts, 6″x3′ 6″ locust.
3 pcs. posts, 6″x4′ 6″ locust.
11 pcs. joist, 2″x8″—16′ 0″ long, hemlock.
11 pcs. joist, 2″x8″— 8′ 0″ long, hemlock.
9 pcs. sills, girders, etc., 2″x8″—16′ 0″ long, hemlock.
14 pcs. plates and joist bearers, 2″x4″—16′ 0″ long, hemlock.
40 pcs. studding, etc., 2″x4″—12′ 0″ long, hemlock.
9 pcs. rafters, 2″x6″—18′ 0″ long, hemlock.
9 pcs. rafters, 2″x4″—10′ 0″ long, hemlock.
50 ft. b. m. patent siding, 5″ face, poplar.
700 ft. b. m. shiplap, 5″ face, poplar.

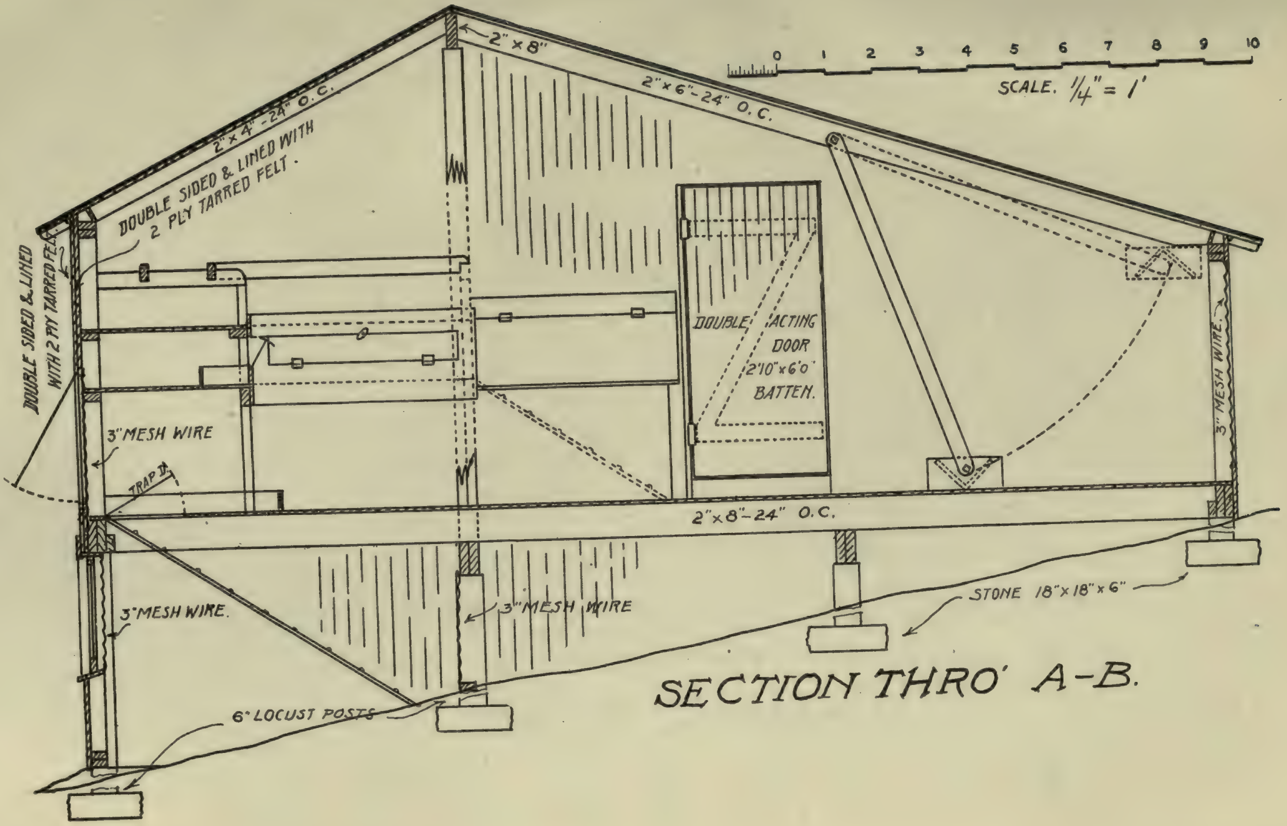
600 ft. b. m. roof sheathing, 4″ common No. 2 y. p. flooring.
350 ft. b. m. double surfaced y. p. ceiling, ⅞″x4″ No. 2 com.
600 ft. b. m. flooring, matched y. p. 3½″ face, No. 2.
75 ft. b. m. ceiling, ⅝″x3″ matched and bearded, y. p. No. 2.
2 pcs. ⅞″x10″—16′ 0″ long, S-4-S, poplar, feed trough.
1 pcs. ⅞″x 4″—16′ 0″ long, S-4-S, poplar, feed trough.
1 pcs. ⅞″x 7″—16′ 0″ long, S-4-S,poplar, nests.
4 pcs. ⅞″x 5″—10′ 0″ long, S-4-S,poplar, nests.
1 pcs. ⅞″x 8″—12′ 0″ long, S-4-S, poplar, gangs.
2 pcs. ⅞″x 5″—12′ 0″ long, S-4-S, poplar, gangs.
1 door frame, 2′ 10″x6′ 0″—½″x1¾″ rebate strip, poplar.
1 door frame, 2′ 8″x4′ 0″—½″x1¾″ rebate strip, poplar.
1 door frame, 2′ 11½″x6′ 5″—fitted with 1½″x1½″ hinge strip for double acting door, poplar.
2 doors, 2′ 10″x6′ 0″—⅞ double surfaced, matched and beaded batten doors with ⅞″x4″ battens, poplar.
1 door, 2′ 8″x4′ 0″—⅞″ double surfaced, matched and beaded batten door with ⅞″x4″ battens, poplar.
1 mullion window frame, 2 single sash, 6 lt. 10″x12″, poplar.
2 sash, 1⅜″—6 lt. 10″x12″, glazed S. S. A. glass.
5 squares composition tarred felt roofing, 2 ply, first quality.
2 squares tarred building felt, 2 ply.
14 lin, ft. mesh wire, 3″ sq. mesh. 50″ wide, No. 20. wire.
14 lin, ft. mesh wire, 3″ sq. mesh. 32″ wide, No. 20. wire.



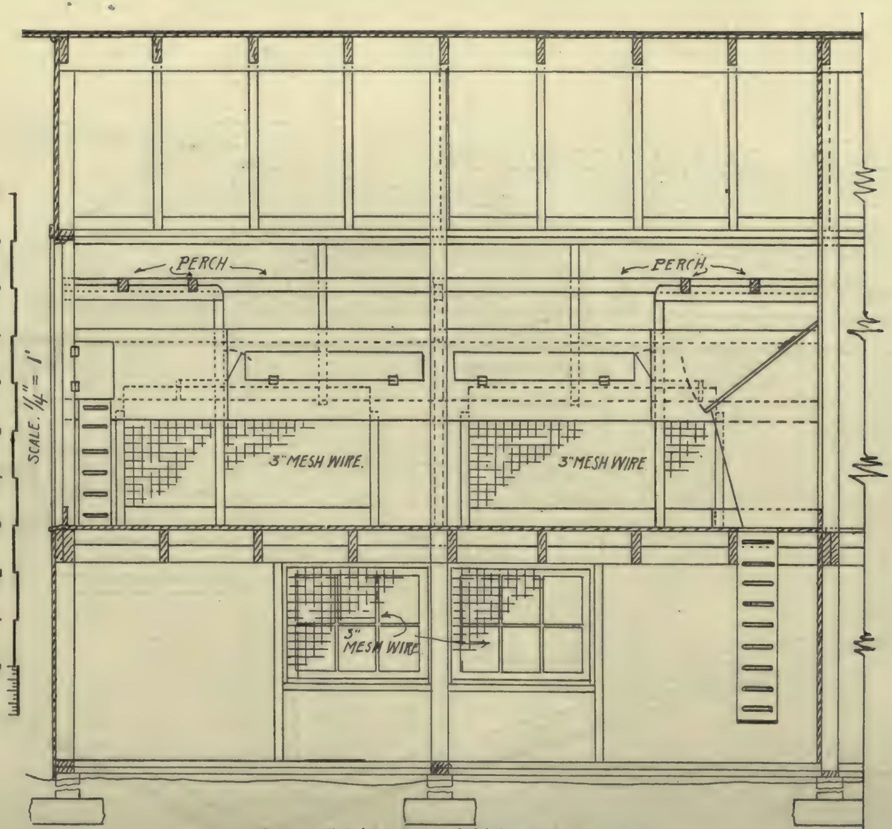
NOTE:
ALL POSTS SET ON 18" x 18" x 6" STONE.
ALL POSTS 6" LOCUST.
SEE SECTIONS.

FOUNDATION PLAN.

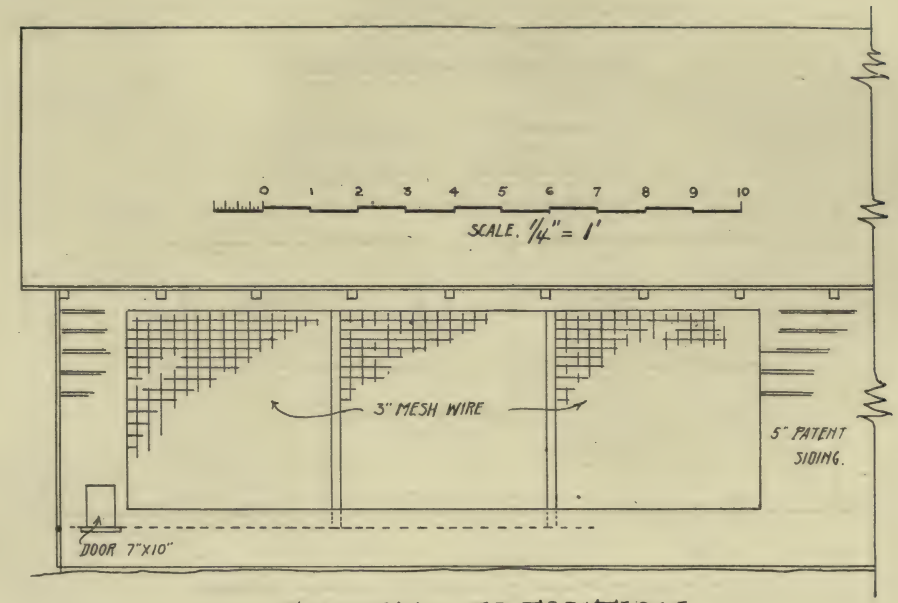

FLOOR PLAN.
DOUBLE SIDED & LINED WITH 2 PLY TARRED FELT
D-2'10"x6'0" BATTEN.
C
DOOR 7"x10" HINGED TO TOP.
DOOR 10"x14"
A
B
3" MESH WIRE.
3" MESH WIRE
16'0"
FEED TROUGH.
0 1 2 3 4 5 6 7 8 9 10
SCALE. 1/4" = 1'
4"x4"
N E S T S
FEED BIN.
PERCH.
D-2'10"x6'0" BATTEN
DOUBLE SWING.
D
24'0"



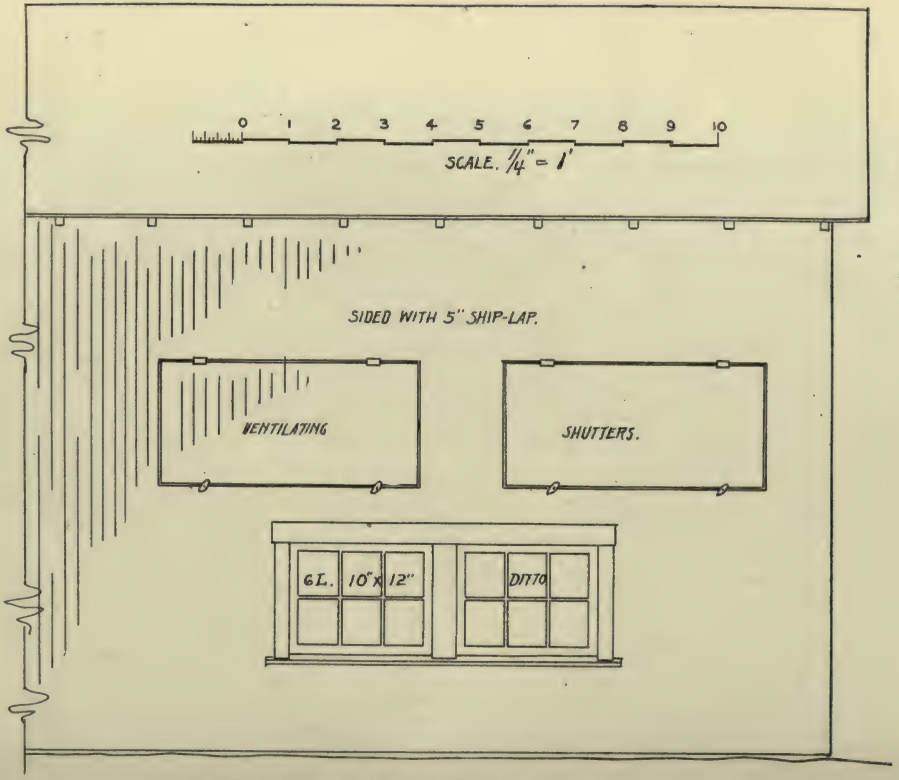
SECTION THRO' A-B.



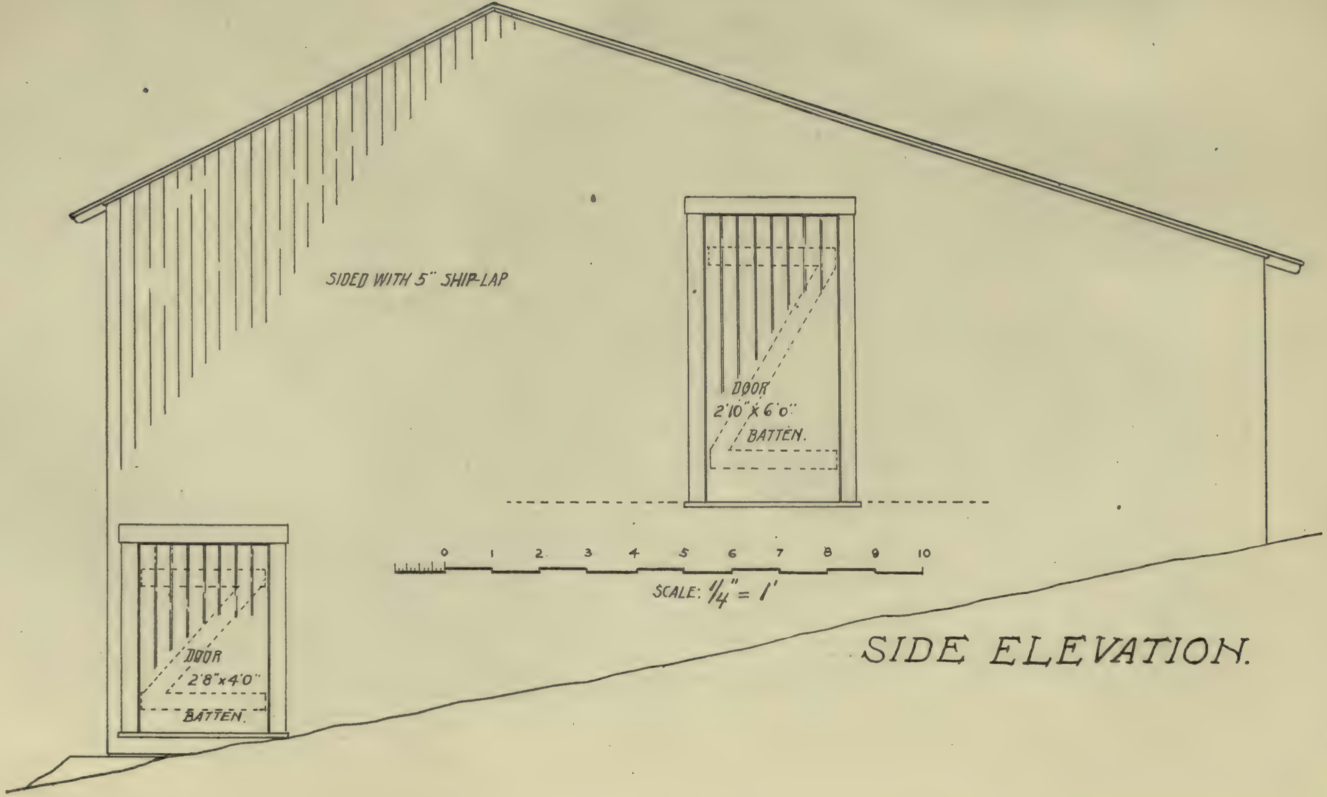
SECTION THRO' C-D.



FRONT ELEVATION



REAR ELEVATION

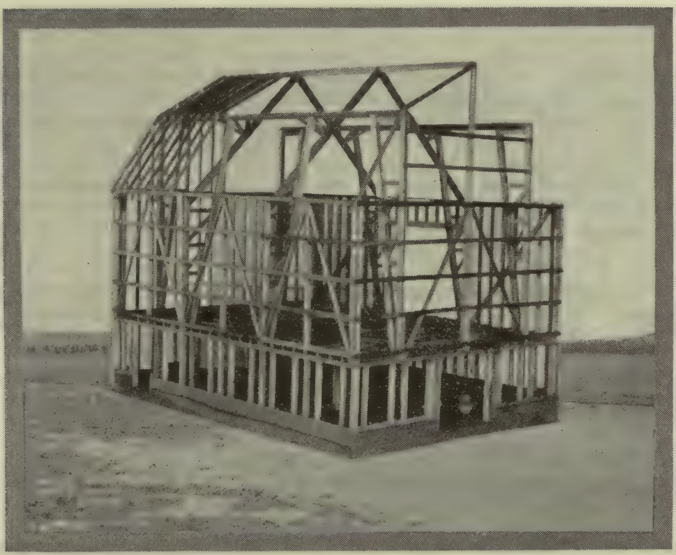


SIDE ELEVATION.

Bulletin 266 April, 1916

Barns for Wisconsin Dairy Farms

FRANK M. WHITE and CLYDE I. GRIFFITH



PLANK FRAME CONSTRUCTION REDUCES THE LUMBER BILL

In building a farm barn it is important that the cost be kept as low as possible without sacrificing comfort, convenience or strength.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON, WISCONSIN

DIGEST

A Well-built, well-lighted, well-ventilated, and well-planned barn is a necessity on nearly every live stock farm. The cost of the barn may vary, for some farmers will install more elaborate conveniences and pay more for architectural style than will others. Page 3.

Barns are practically standardized, in regard to framing and interior arrangement. The cost of wood and other materials makes it necessary to make a more careful study if savings are to be made. Page 3.

Build a barn large enough to meet future needs and to permit the handling of the maximum capacity of the farm. If the new barn just holds the stock at time of building another barn will probably be needed soon. Page 4.

The location and drainage of the barn are important. The location should be at least 200 feet from the house and handy to a well, sheds, and granaries. Drainage is necessary if the stock is to be kept healthy. Page 5.

Rectangular shaped barns are more satisfactory than round ones. In Wisconsin, the barn should have its length run north and south if the largest possible amount of direct sunlight is to be let inside. Pages 5–8.

A ventilation system is required if the animals are kept healthy. It also regulates the temperature and furnishes fresh air. The King system is best adapted to Wisconsin conditions. Pages 9–15.

The barn must be kept clean. The manure can either be removed every day or the stalls bedded heavily and the manure removed every week. It is best to clean out the barn every day. Pages 16–22.

Gambrel roofs give more room for hay than do the gable roofs. This is an important point to consider. Pages 23–26.

Concrete is the best product that can be used for the foundation ground floor and wall of the barn. Sand and gravel are often found on the farm where the barn is built. Concrete must be well mixed and reinforced if it is to give the best of satisfaction. Pages 26–28.

Plans are described in this bulletin for three general purpose barns, one single story dairy barn, and a pioneer barn. Blue prints can be secured from the Agricultural Experiment Station. Pages 29–32.

Barns for Wisconsin Dairy Farms

While Wisconsin's climate is ideal for the production of vigorous and healthy live stock its rigor makes a well constructed, well lighted and well ventilated barn a necessity on every well equipped stock farm.

> Successful animal husbandry requires not only healthy stock but adequate and sanitary quarters in which to rear them. Climatic conditions which prevail in Wisconsin require that specific attention be given the matter of housing live stock. Fresh air is essential to health. Sunlight is one of the most powerful disease-destroying agencies known. To retain as much of these properties as possible and at the same time give adequate shelter from winter cold and summer heat is the object sought in the construction of the barn of the live stock farmer. The cost of such an improvement is considerable; consequently the prudent manager will carefully study his needs so as to secure the best equipment for his money.—H. L. Russell, Director.

Conditions, however, in the various sections of the state and upon the various types of stock farms are not sufficiently alike so that one plan will meet the demand of everyone. The right barn for one man or for one farm may not in any way meet the requirements of another. One man may, in building his barn, consider, mainly, ways of reducing the need of labor; another may plan his barn so as to aid him in the display and sale of his stock. Then, too, one may care more for architectural style and modern conveniences than his neighbor and be willing to spend more in order to secure these features.

Barn building, however, so far as design of framing and interior arrangement are concerned, is rapidly becoming standardized. The general requirements of barns are very similar, and the four designs described at the end of this bulletin and which may be secured by writing to the agricultural engineering department are planned to meet as nearly as possible the needs of Wisconsin farmers.

The high price of materials and the too often extravagant use of them in building, has caused the majority of farmers to reduce the amount of wood used in constructing their barns and to make a judicious selection in order to secure the best kind of wood.

In the past, barn framing has been done by "rule of thumb." In order to save material and to insure the necessary rigidity of the structure, more attention is now being given to the strength of materials and to matters of design.

BUILD TO MEET FUTURE NEEDS

A barn should not be built just large enough to accommodate the stock on the farm at the time of its building. A good manager considers his farm as a factory and expects to work his "plant" to its maximum economic capacity. The barn is an important part of the farm factory plant and should be large enough to accommodate all the animals the manager can care for efficiently. The size can be determined only after a careful study of the number of acres in the farm and the quality of stock.

Over capitalization is perhaps as poor a policy as under capitalization. But the dairy farmer, especially, can afford to have a substantial, well arranged, well lighted, and well ventilated building.

BUILD ON WELL DRAINED SITE

The first essential of a barn site is proper drainage. With basement barns, which are the most common in Wisconsin, it is difficult to obtain perfect drainage. The chief object in building a basement barn is, as a rule, to provide an easy driveway into the second floor; but as hay and grain can be elevated easily or a bridge built leading to the second floor, light and drainage should not be sacrificed for the doubtful advantage of having a basement.

A driveway can be built to the second floor that will not shut out indirect light. In order to do this a concrete wall needs to be built about eight feet from the barn and either a reinforced concrete bridge or a wooden bridge should connect the drive with the barn. The driveway in the barn should be from 12 to 14 feet wide, and the drive approaching the barn about 10 feet in width. It is expensive to give up space in the barn for a driveway for in reality, very little use is made of it. Ordinarily such a driveway is used largely to drive into if caught with a load of hay on the wagon during a rain storm. Several tarpaulins large enough to supply this need can be purchased at a less annual expense than that incurred by the driveway.

LOCATING THE FARM BUILDINGS

The arrangement of the yards and fields, and the location of the well, machinery shed and granaries should be considered carefully in locating the barn. It should be at least 200 feet from the house and in such a position that the prevailing winds do not carry the odors from the barn towards the house. Under the best sanitary conditions possible there will be some odor from the barn and the amount of time saved in going to and from the barn by having it close to the house, will not be due compensation for enduring the obnoxious odors. The barn should not be made the most conspicuous farm building. It is secondary to the house and should be so located as not to obstruct views from the house. Usually a location at one side and somewhat to the rear of the house will be found the most suitable.

If it is impossible to have drives leading both to the barn and to the house, the barn should be so located that either the service drive or a branch of it may be made to serve the house. This does not mean that a drive must come within a few feet of the house, as is so many times the case, but it should be convenient. It is undesirable to have the service drive for the barn, over which heavy hauling and delivery of hay and straw is to take place, close to the house. The drive should be so located that it may be screened off by the proper planting of the lawn surrounding the house.

RECTANGULAR BARNS MOST COMMON

There are two general shapes of barns, round and rectangular. The great majority of barns are rectangular. While there are differences of opinion as to the relative merits of the two shapes it is generally considered that the rectangular plank-frame construction is the more standard and satisfactory.

The best arguments for the round barn are:

(1) As a greater area can be enclosed by a circle than by a rectangle of the same wall length, it is cheaper to enclose a given floor area by a circular than by a rectangular wall, (Figure 1); (2) Circular construction is claimed to be stronger and to give greater convenience.

Some of the objections to the round barn and the advantages claimed for rectangular construction are:

(1) In a round barn the silo must, for convenience in feeding and for roof support, be located in the center. This location is inconvenient for filling, and unless care is taken in keeping silage cleaned up the odor from it is objectionable; (2) Unless designed for a dairy barn and all interior arrangements are circular in form, there is much waste space. A certain sacrifice of stable and hay-mow-room is made by locating the silo in the barn; (3) As the hay must be unloaded inside a barn bridge leading to the second floor is required. Barn bridges are not always convenient and much space is wasted from the floor to the roof where hay is drawn up; (4) The center of the barn is poorly lighted which in a dairy barn is a very objectionable point; (5) The construction of a round barn prohibits the economic use of rafters for if they are placed the proper distance apart at the plate they are too close at the top; and (6) There is considerable difficulty in securing carpenters experienced in round barn construction; (7) It is more difficult to secure proper ventilation in a round than a rectangular barn,

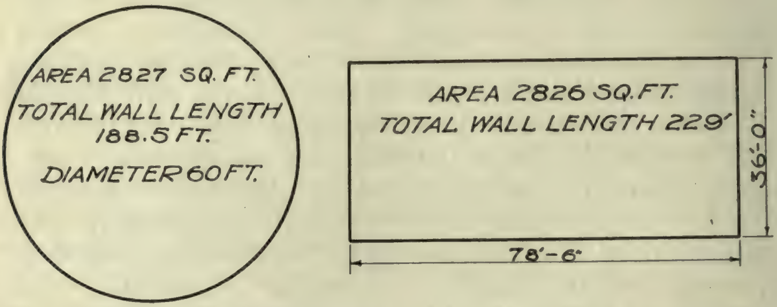


FIG. 1.—MORE AREA ENCLOSED BY CIRCULAR THAN BY RECTANGULAR WALL

Because a circular wall will enclose more area than a rectangular wall of the same length it is cheaper, from the standpoint of area enclosed, to build a round barn.

SUNLIGHT IS THE BEST DISINFECTANT

A barn should be lighted, so far as is possible, by direct sunlight. Sunlight is a great disinfectant and the best sanitary conditions can be obtained only in a well lighted barn. Darkness and dampness are serious objections to bank barns. The only good point in favor of the bank barn is warmth. Warm basements with good walls may be secured by building in a sheltered spot or by having a bank not over four feet high on one side. Window space should never be sacrificed for a bank barn.

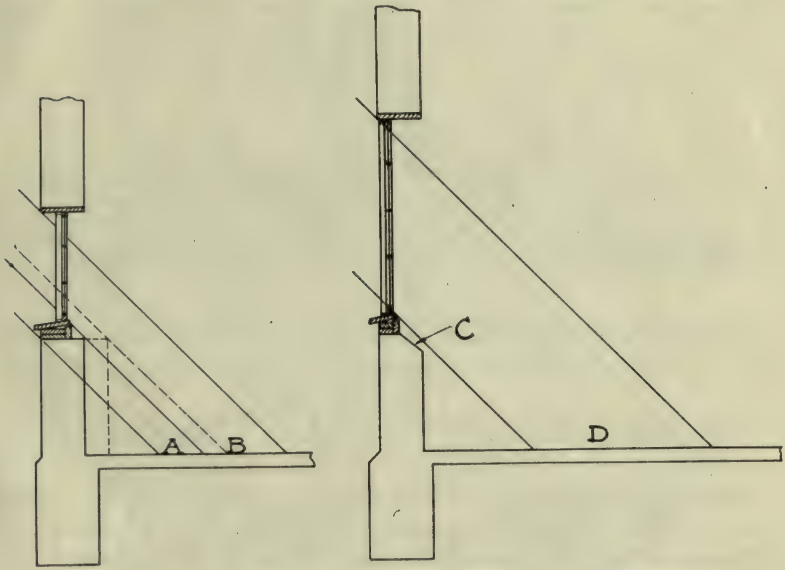


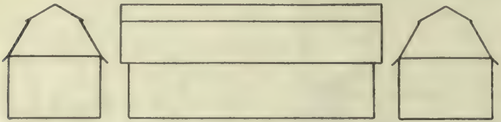
FIG. 2.—LONG UP AND DOWN WINDOWS BEST.

The long up and down window admits direct sunlight farthest into the barn and over a greater area as showed at D. Dotted lines show sunlight which would be cut out by 18 in. wall. Wall should be finished as shown at C.

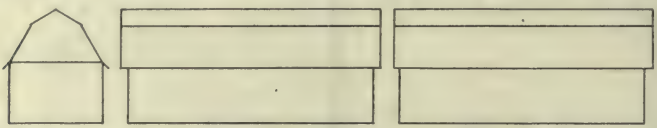
The amount of lighting surface required in a barn is four square feet of window glass to each animal, or one square foot of glass for 20 square feet of floor space. The amount of direct sunlight entering through any window will depend on the length of the window, rather than on the width, the length of the overhanging eves and the thickness of the wall. The long dimensions of all windows for barns should be up and down as shown in Figure 2.

It is a mistake to put windows in a barn with the long dimensions horizontal. Up and down windows admit the sunlight further into the barn. The dotted lines represent the amount of sunlight cut out by the ordinary 18 inch stone wall.

The direction in which the barn stands has much to do with the amount of direct sunlight that enters it. In Wisconsin, if the barn stands east and west, direct sunlight enters only through the south, east and west windows, and only indirect sunlight on the north. A barn standing north and south receives direct sunlight on both of the longest dimensions each day, or on the east and west, as well as on the south side, and indirect on the north side. As far as possible, buildings should be lighted from the south in the middle northern latitudes, as the maximum amount of direct sunlight may thus be obtained, by either an east and west or north and south arrangement, provided windows are not obstructed in either position. The barn should be placed with long dimensions north and south if a bridge or bank is to be built to the second floor. A barn standing north and south is generally cooler in the summer time as the prevailing winds from the south and southwest create a draft through the barn. In the winter time there is very little difference as far as temperature is concerned.



AREA RECEIVING DIRECT SUNLIGHT —LONG DIMENSION E.&W.



AREA RECEIVING DIRECT SUNLIGHT—LONG DIMENSION N.&S.

FIG. 3.—MOST SUNLIGHT ADMITTED IF BARN RUNS NORTH AND SOUTH

If the long dimension of a Wisconsin barn is placed north and south the sun shines on the two sides and one end; if placed east and west, on two ends and a side.

VENTILATION NECESSARY TO ANIMAL HEALTH

Barn ventilation is necessary to regulate temperature, to remove the moisture and bad air and to provide fresh air. When human beings live in poorly ventilated rooms their efficiency is reduced and they are easily attacked by disease. The effect on animals may be expected to be the same. Poor ventilation in stables is easily detected by an accumulation of moisture on the walls and ceiling during warm weather, and by frost in cold weather. In Wisconsin, where it is necessary to keep animals in the barn during the winter, it is absolutely essential to have a ventilating system.

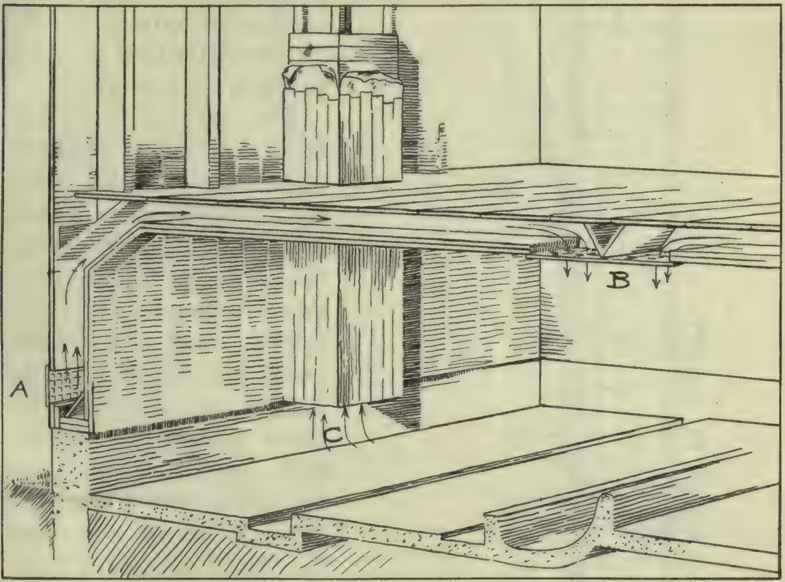


FIG. 4.—LETTING FRESH AIR IN AND FOUL AIR OUT

The arrows show how the air is brought into the barn through the inlets and the foul air drawn out at the outlets.

The King system of ventilation, devised by the late F. H. King, for years connected with this Station, has come to be generally adopted for barn ventilation. It has been widely used in all climates and has proven as satisfactory as can be expected from a partially automatic system. No ventilating system yet devised is entirely automatic so even the King system will need some attention. In the upper part of the

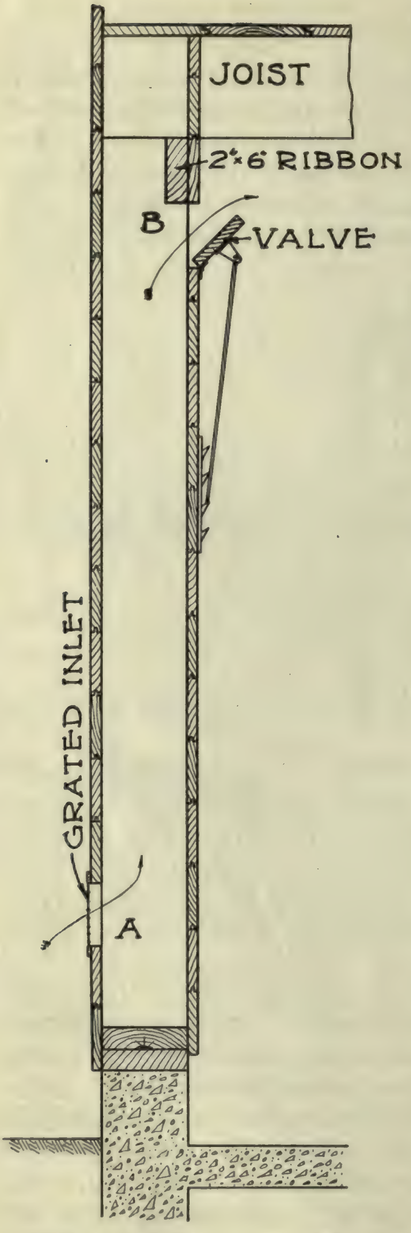


FIG. 5.—A VALVE INTAKE

The amount of air entering barn can be controlled by the valve built in some intake flues.

state the temperature is at times so low that an adequate supply of air cannot be furnished without producing too low a temperature in the barn, but under general temperatures conditions it is possible to ventilate the barn adequately, if the proper attention is given to the King system.

The efficiency of the King system depends upon the location, size and straightness of the intake flues and outlet flues, practically air-tight, non-conducting walls and ceiling, and good tight doors and windows. As in any natural or automatic system of ventilation, no provision can be made to warm the incoming fresh air except the heat supplied from the bodies of the animals. The fresh air is warmed by mixing it with the warm air of the barn at the ceiling before it is breathed.

These fresh air intakes are located at 12 to 14 feet intervals along the side of the barn wall. The minimum length of the flue must be five feet between A and B, Figure 5, so as to guard against air flowing outward. It is very important that the inlet flue be covered with fine wire screening to prevent the flue from becoming obstructed. The valve or register should be arranged to open and close so as to prevent drafts in the barn and to keep the stable from becoming too cold during

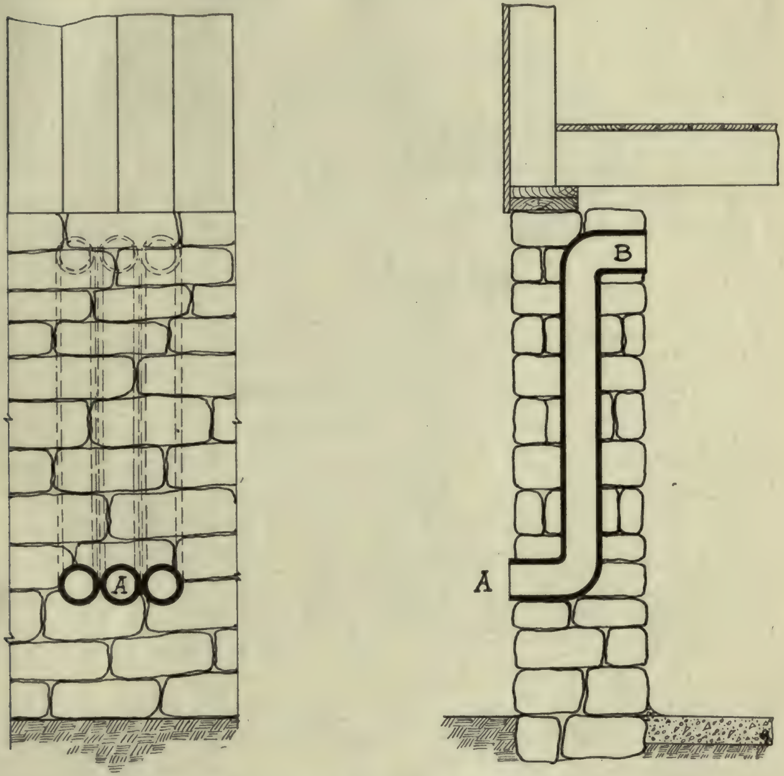


FIG. 6.—INLET FLUE IN STONE WALL

Vitrified sewer tile or galvanized iron pipe may be used to provide the air passage in masonry wall.

the extreme winter season. A register, similar to those used for hot-air furnaces, may be installed in place of the damper.

The foul air flues are made of galvanized iron, insulated, or of paper and lumber. The design of these flues is of the greatest importance to the success of the ventilating system. They should be as straight and smooth as possible for every turn or bend reduces the carrying capacity of the flue. If it is necessary to pass around a bend, the flue should be enlarged so that its capacity will not be reduced. The ventilating flue acts as a chimney and should therefore, rise above the highest part of the building in order to receive the full force of the wind. The velocity of the wind, as well as the difference in temperature between the inside and outside make the flue draw.

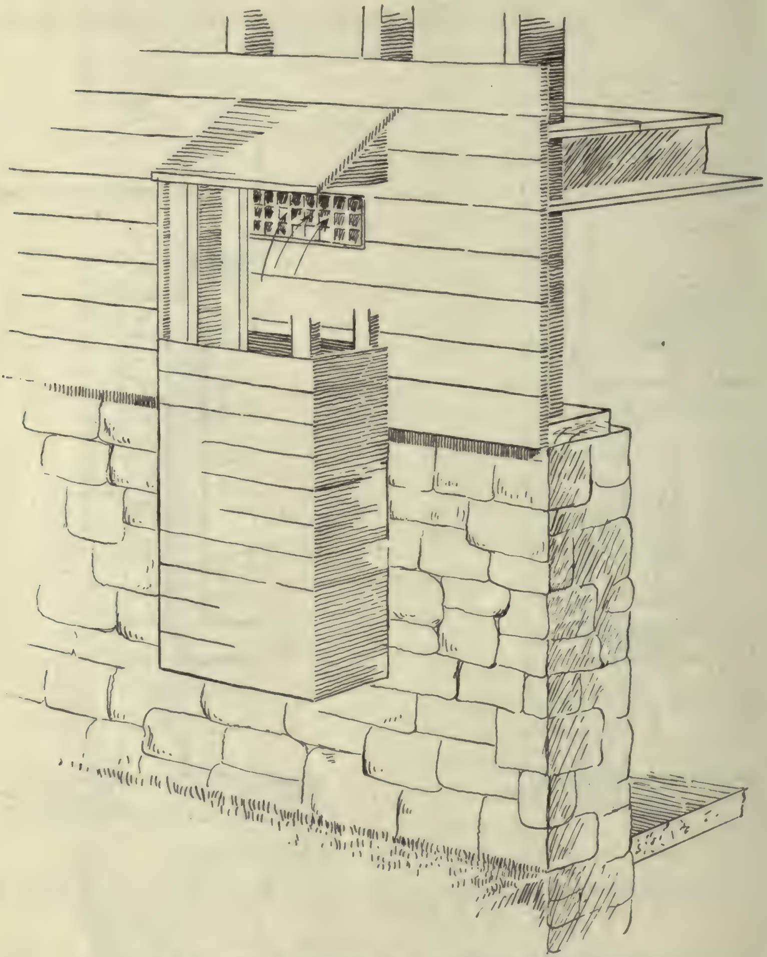


FIG. 7.—INLET FLUES ADDED TO OLD BARN

Fresh air inlet flues can be added to any barn with but very little expense.

It is important that great care be taken in locating the outlet flues. These should not be placed too close to the heads of the cattle for if they are, all of the foul air will pass directly by the animals and much of it will be breathed in by them. Neither should the outlet flue be placed near the entrance where the opening of the door would break the drawing action of the flue. The outlet flues should be so located as to be out of the way as much as possible and yet be so distributed about the stable as most readily to draw out the foul air.

Windows may be so arranged as to provide ventilation but in this climate should never take the place of the King system. In case windows are to be used for ventilation they should be hinged at the bottom and open inward from the top. At either side is a galvanized iron shield which prevents air entering at the sides of the window and blowing directly on the cattle.

FLUES MUST BE PROPERLY CONSTRUCTED

Much of the success of the King system of ventilation depends upon the construction of the flues. Figure 8 shows detail of construction of an outlet flue. The cost of such a flue will average 75 cents a foot of length. If made of galvanized iron, the flue should be well insulated, otherwise the moisture passing through the flue will be condensed and fall as water. Insulating a round or square galvanized flue is generally impossible except by a commercial concern. This will increase the cost of installation.

BUILD FLUE THE RIGHT SIZE

In this system the total area of the outlet flues should practically equal the area of the inlet flues. If the windows and doors are not tight the number of inlet flues should be reduced so that their total area should only equal two-thirds of that of the outlet flues as there will be enough air entering the cracks to furnish plenty of fresh air.

A convenient size of outlet flue is 18x24 inches or 16x22 inches. In figuring the size of flue the number of animals should be carefully considered. The following data taken from King's Physics of Agriculture will be found to be of service in computing the size of inlet and outlet flues.

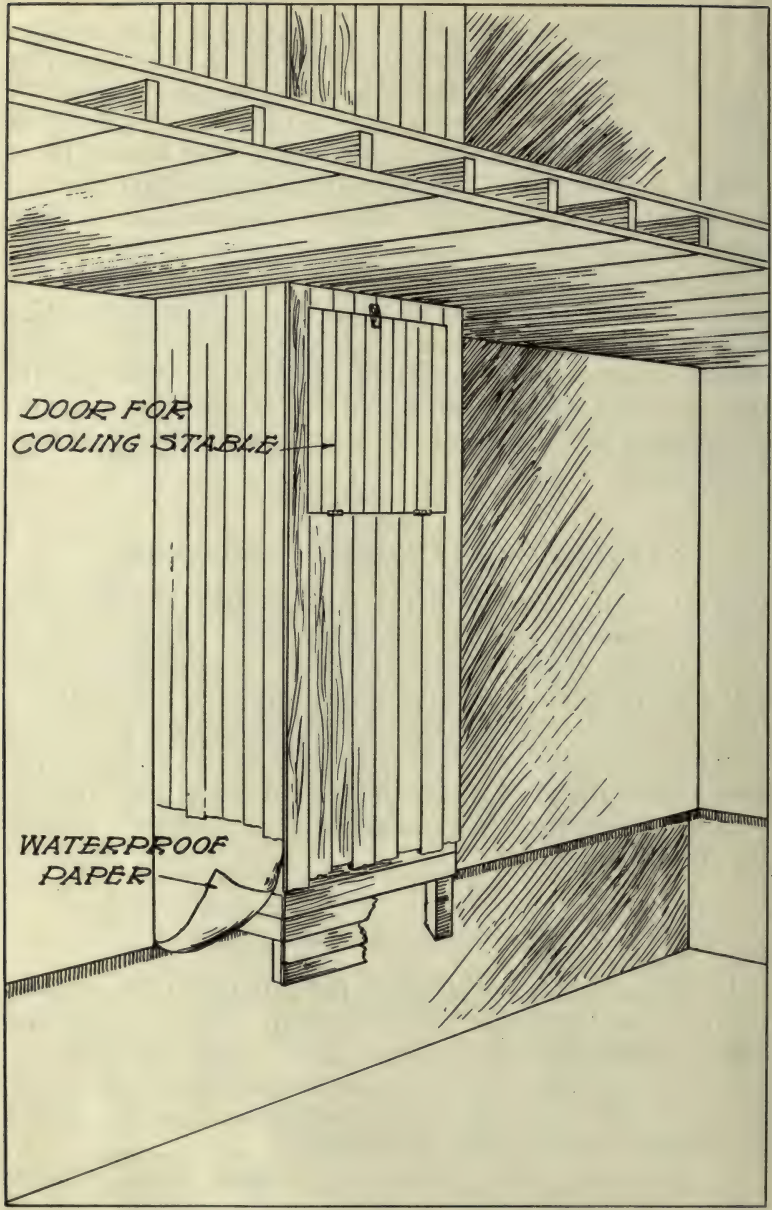


FIG. 8.—MUCH DEPENDS ON OUTLET FLUE

The success of a ventilating system depends to a considerable extent upon the outlet flue. The opening of the foul air flue is placed one and one-half feet above the floor. In this construction water-proof building paper is placed between the two layers of seven-eighths inch flooring.

AMOUNT OF AIR REQUIRED FOR BARN VENTILATION

Horses	71 cubic feet an animal a minute
Cows	59 cubic feet an animal a minute
Swine	23.2 cubic feet an animal a minute
Sheep	15.3 cubic feet an animal a minute
Hens	.52 cubic feet an animal a minute

Assuming that air travels through a flue from a stable at the rate of 290 to 300 feet a minute, the size of outlets and inlets may be determined as follows:

$$\frac{\text{Total no. of cu. ft. of air required}}{300} \times \text{144 sq. in. in 1 sq. ft.} = \text{Total cross-sectional area sq. in. of inlets or outlets.}$$

$$\frac{\text{Total cross sectional areas of outlets}}{\text{No. of outlets}} = \text{Cross-sectional area of each outlet.}$$

$$\frac{\text{Total cross-sectional area of inlets}}{\text{No. of inlets}} = \text{Cross-sectional area of each inlet.}$$

To estimate the amount of air required for a herd of 27 head of cattle and for five horses we would multiply 27, the number of cattle by 59, the number of cubic feet of air required for a cow, which is 1,593. To provide fresh air for the horses multiply 71, which is the number of cubic feet of air required for one horse by 5, the number of horses to be kept. This equals 355 cubic feet. The total requirement then would be 1,593 cubic feet for the cattle and 355 for the horses or a total of 1,948 cubic feet.

In order to get the total cross-sectional area of either outlets or inlets divide 1,948 by 300 (the rate at which air travels a minute in the flues of a stable) and you would have 6.49. Multiplying 6.49 by 144 (the number of square inches in a square foot) would give 934.5, the total cross-sectional area in square inches of inlets or outlets for this barn. Now the total required area 934.5 will be divided by the number of flues to be provided. A sufficient number of inlet flues should be provided so that the fresh air will enter the barn every 10 to 12 feet. This barn being 36x86 feet, the inlet flues spaced at 12 feet intervals would require 18 flues.

To get the area of each inlet divide the total cross-sectional area of inlets by 18 (1,948 ÷ 18 = 52) and each flue should have an opening of 52 square inches. A 6x8 inch inlet flue comes nearest to providing this amount.

The total cross-sectional area of the outlets divided by four (1,948 ÷ 4 = 234), which is the number of outlets that will remove the foul air from all parts of the barn, gives a total area of 234 square inches for each outlet. This area will be secured in a flue 16 x 16 inches. The area of the outlet flues should be a little greater than that of the inlets.

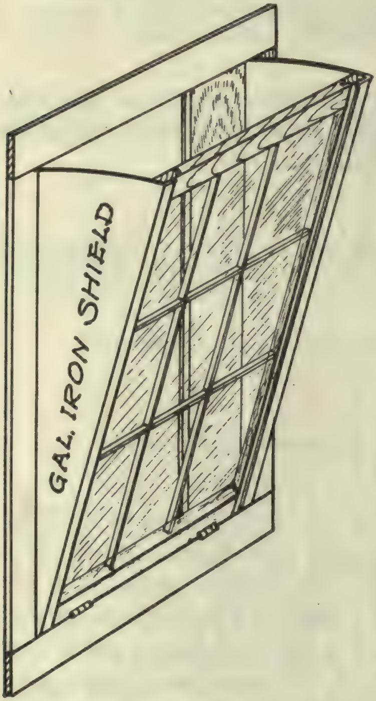


FIG. 9.—HINGED WINDOW VENTILATOR

The galvanized iron shields prevent the air from entering at the sides and blowing directly upon the stock.

Take Care of the Manure

A dairy barn or a general purpose barn, must be kept clean as it is a place where human food is produced. The barn floor should be so constructed as not to allow water to pass through it, should be free from cracks and crevices, and reasonably smooth so that it may be cleaned easily. There are two methods practiced in caring for manure. One system is to bed stalls heavily and to clean out the manure every week. The other is to clean the barn daily, hauling directly to the field or storing the manure in a manure pit. The latter system is, from the standpoint of cleanliness, the only satisfactory one.

Supplying Fresh Water

If a water supply system is available, running water can be piped directly into the barn. There are several companies making satisfactory automatic water systems that require little attention. A common method of watering is that of using the manger as a watering trough. This is satisfactory if proper attention is given to cleanliness.

CONVENIENT ARRANGEMENT SAVES WORK

The width to build.—The width of barns is practically standardized at 36 feet. This width is most satisfactory for a double row arrangement of stock. More than two rows of stock are undesirable on account of the difficulty of lighting and because of the narrow alley which results even in a 40 foot width. A barn 34 feet wide is fairly satisfactory although the alleys must necessarily be narrower than in a barn 36 feet wide.

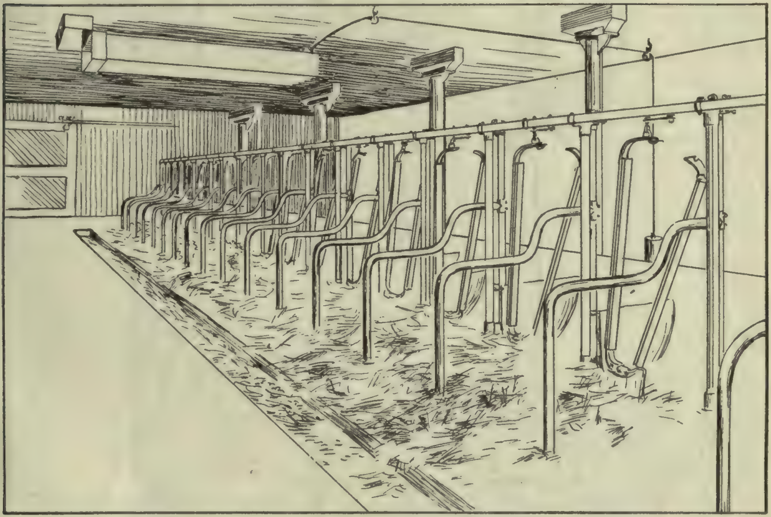


FIG. 10.—A HINGED VENTILATING FLUE

If the main ventilating flue is connected with the stable by means of a hinged ventilator, this can be drawn out of the way during warm weather. This outlet flue should not be located in center feed alley if the cattle face in.

It is difficult to design an interior arrangement of a barn to meet all requirements. The exact dimensions of stalls, mangers, gutters, alleys and driveways are partially a matter of individual opinion. There are, however, some dimensions that should be adopted in the building of every well designed barn.

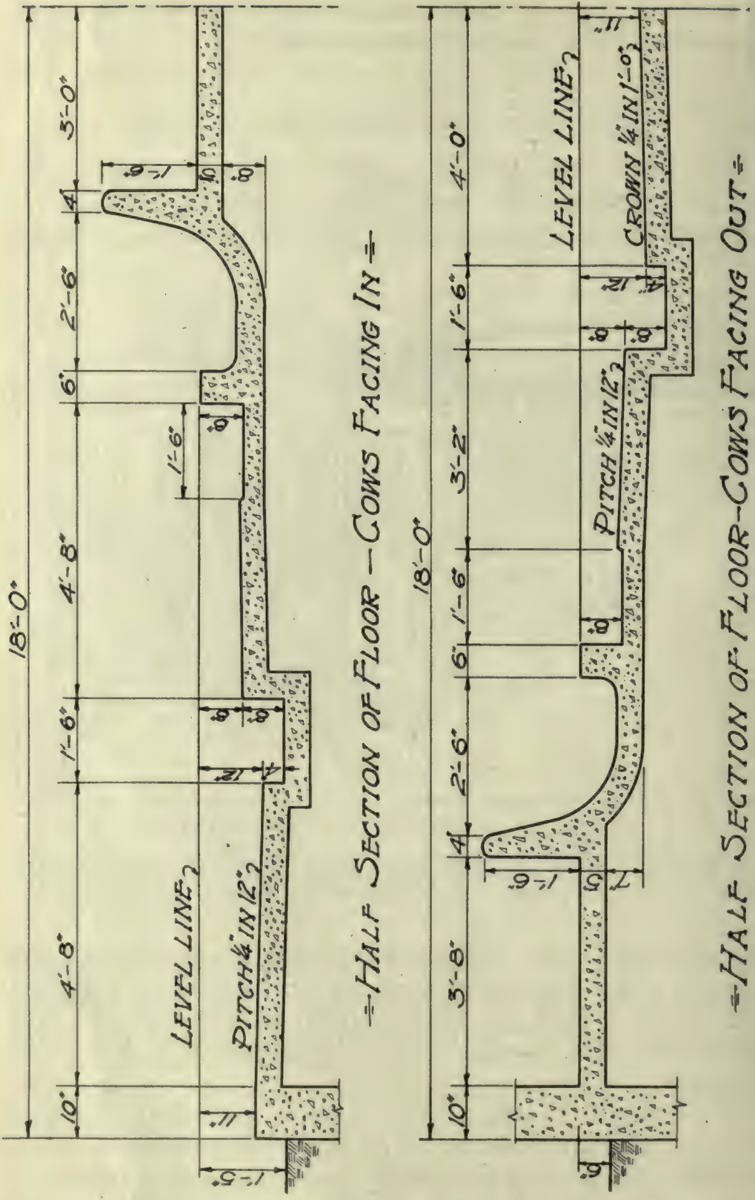


FIG. 11.—THE COW STALL FLOOR SHOULD BE CAREFULLY PLANNED

It is important to have the feeding alley, the manger, the stall platform, the gutter, and the litter alley or driveway of good dimensions.

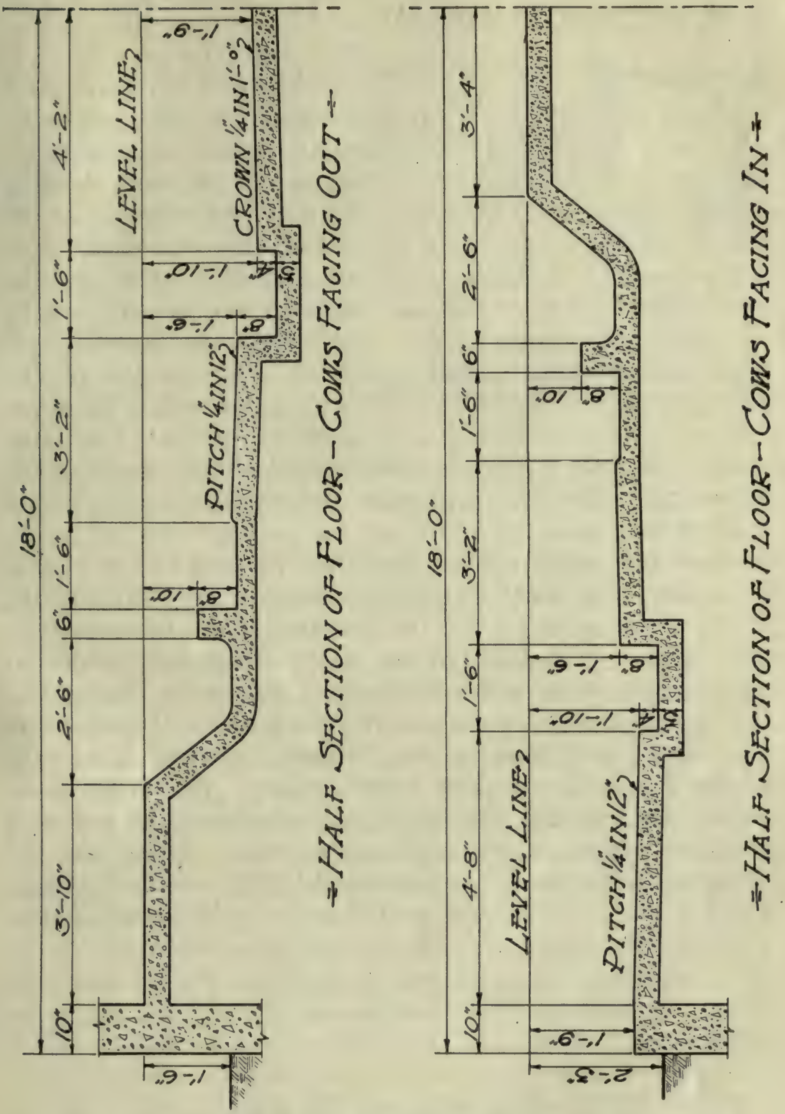


FIG. 12.—FEEDING FLOOR LEVEL WITH TOP OF MANGER

It is largely a matter of choice whether the feeding alley be raised above or be built upon the level of the stall floor.

The size of stalls varies.—The width of mangers is practically standardized at two feet six inches. The average length of a cow stall, from the manger to the edge of the gutter, is four feet eight inches. If it is necessary to vary this length, the stall could be constructed four feet six inches at one end, slanting to five feet or more, at the other. By having the stall of correct length all the manure can be confined to the gutter and the cows kept clean. The width of the stall is standard at three feet six inches. For large cattle, weighing 1,400 to 1,600 pounds, it will probably be necessary to make the stall three feet eight inches wide and five feet long.

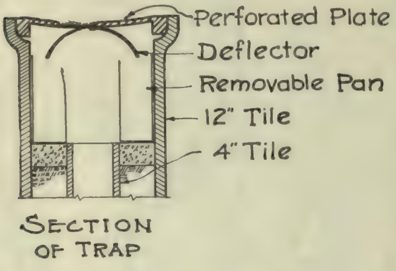


FIG. 13.—A GUTTER TRAP

To prevent clogging of the drain pipe leading from the stable gutter a homemade trap may be built in.

While the gutter width varies from 14 inches to 20 inches, 18 inches is the most satisfactory width. The depth of the gutter at the edge next to the cow should not be more than eight inches. The depth at the rear of the gutter should not be more than four inches as shown in Figure 12. The gutter should have a slight slope away from the cows. It should also be given a slope of two inches in 50 feet lengthwise of the barn so that the gutter may be flushed easily. This slope is desirable for flushing the liquid manure especially where a cistern is provided. In long barns of more than 50 feet, the slope should be from the ends towards the center. For such a slight slope, the gutters must have a very smooth finish. To prevent clogging of the drain pipe some means should be used to prevent the entrance of chaff and other coarse materials. A homemade trap as shown in Figure 13 will serve this purpose.

WIDE FEED ALLEYS BEST

Feed alleys should be four or more feet in width. Cows have a habit of pushing forward in their stalls which makes it all the more difficult to feed from alleys of less than four feet. Passageways between long rows of stalls or at ends of stalls can be two feet when used largely at milking time to save time in walking around long rows of stanchions.

SHALL COWS BE FACED IN OR OUT?

Whether it is better to face cows out from, or toward a center isle is an open question; good arguments can be made in favor of either arrangement. One of the chief advantages for having the herd face the center isle is that this arrangement provides a central feeding alley. It, of course, is more convenient to feed from one alley, especially if feeding ensilage. Careful feeding is very necessary to successful dairying and as cattle are fed two or three times a day this point deserves considerable attention. Then, again, when the cows are faced in there is no danger of the direct sunlight affecting the cow's eyes. This arrangement places the milkers nearest the light so that they can see that the cow's udders are clean. Cleaning out the manure is as easy, if a litter carrier is provided, as driving through the barn between two rows of cows. A feed carrier can be installed running between the two rows of cattle and be used to carry feed to various parts of the barn.

The advantages of having the cattle face out are: first, less alley space is required, (when cattle face the center aisle the back walks must be wide or the walls will be spattered with manure); second, a manure spreader can be loaded in the barn and hauled directly to the field, thereby saving handling the manure twice; third, sale cattle can be shown to better advantage when facing out from the center and it is claimed by some that it is easier to get cows in and out of the barn with less danger of crowding.

STALL FLOORS SHOULD BE SANITARY

Wood floors are insanitary and last but for a very short time. A good concrete floor, well drained, with a wood overlay, or well bedded, is entirely satisfactory. In constructing the wood overlay (Figure 14) the boards should be laid lengthwise of the stall. It should be made so as to be easily removed, thus permitting cleansing. A concrete floor, to be satisfactory, must be finished with a wood trowel which will leave the surface rough enough to prevent the cows from slipping and also to make it possible to keep bedding on the floor.

Cork brick are quite extensively used for flooring and are very satisfactory, but more expensive than concrete or wood. These are sanitary and are not cold, as is the case with concrete. They will last much longer than the ordinary wood floor.

Wood blocks soaked in creosote and laid on a concrete foundation are cheap and serviceable for cow stall floors.

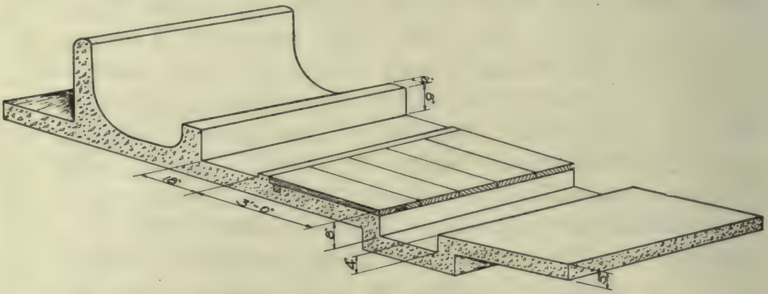


FIG. 14.—A WOOD OVERLAY FOR THE STALL FLOOR

A concrete floor should be covered with bedding or a wood overlay. It can be kept in a sanitary condition.

One living near a city where a wood block pavement is being constructed can usually secure the blocks either from the contractor or from the city.

HAVE FEED ROOM CONVENIENT

In a dairy barn the feed should be stored in a convenient place at either end of the feed alley. The feed-bin is usually placed on the second floor and should be connected directly with the feed room by means of a chute. This feed room should be close to, or a part of, the silo room and so arranged that it may be entirely shut off from the main part of the barn.

PROVIDE A BULL PEN AND MATERNITY STALLS

A bull pen and one or more maternity stalls are needed on a dairy or stock farm. The maternity stalls should be approximately 10x10 feet and be provided with an abundance of light. A convenient arrangement for the bull stall is shown in Figure 15. Itprovides for two outside doors, one for the bull to come in through, the other to go out. Such an arrangement makes it unnecessary to enter the stall, the exit door can be opened from the outside, the bull untied from the front and allowed to go out and exercise. It will be noticed that in this arrangement the bull cannot turn around and that there is no necessity of getting into the pen either to turn him out or to tie him.

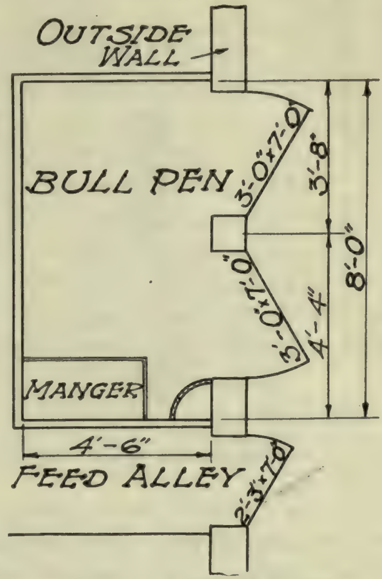


FIG. 15.—SAFETY FIRST

This pen is so arranged that the attendant can care for the bull without entering the stall.

SEPARATE MILK ROOM PREFERABLE

A milk room should be located near, but preferably not inside the dairy barn. The entrance to the milk room, it is often urged, should be gained from the barn only after going entirely out of the stable. Milk, of course, is easily contaminated by odors. This room could be conveniently located underneath the barn bridge or near the entrance of the barn. It is exceedingly important that the gas engine for operating the separator be outside the milk room. Gas contaminates milk and the odor can be detected in the butter.

DETAILS OF CONSTRUCTION

Too many of us when thinking of building a barn start at the wrong end. A fixed dimension is generally considered and then the problem is to get all the stock on the farm into this building. A better method of arriving at the size of a barn is to consider the number of cattle or horses to be put into the building. Thirty-six feet seems to be the standard generally adopted for the width of a barn.

Many in planning their farm structures desire permanency. Concrete, brick, stone or concrete block are very satisfactory for walls. The walls, if built of solid concrete, should be from 10 to 12 inches thick, and well reinforced around corners and doorways as shown in Figure 16. The walls may be of any height but it is advisable to build them either to the bottom of the windows or to make an entire masonary basement.

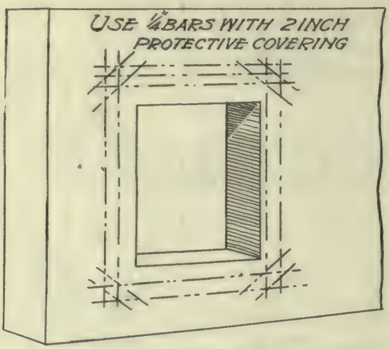


FIG. 16.—OPENINGS WELL REINFORCED

It is important that concrete walls, especially about openings and around corners be well reinforced. The material used to reinforce the wall should be protected by two inches of concrete; otherwise the rust will weaken it.

An all fireproof barn is of doubtful value. The hay and straw, stored in the haymow are of such a character that the great heat in case of fire would be likely to cause the solid wall or roof to crack on the explosion of the gas generated from the fire. There is no doubt, however, of the value of a fireproof basement.[1] Such a construction is within the reach of any man who can afford to put $4,000 into a barn.

PROTECT AGAINST LIGHTNING

Barns are less likely to be damaged by lightning if rods are used. Investigations by the farmers' mutual fire insurance companies proves that the damage to rodded barns by lightning is low in comparison with the damage to unrodded barns. Many reports on the use of the lightning rod show that it is from 80 to 99 per cent efficient on farm buildings.

Iron and copper or combinations of the two are the commercial materials available for lightning rods. Both of these materials give equal satisfaction. The important points in selecting and installing the lightning rod are:

(1) Do not use insulators. Fasten the rod directly to the building; (2) The rod should be made of a material which will resist the action of weather and soil; (3) Joints must be rigid and permanent. Screw joints are considered best; (4)

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[1] The complete design of a reinforced concrete barn basement can be secured for five cents by applying to the Agricultural Engineering department, University of Wisconsin, Madison.

Earth connections should be made to a point of permanent moisture; (5) Terminals must be rigid, well supported and should be made of solid material; (6) Terminals are placed at distances of about 25 feet, on ventilators, silos and chimneys; (7) All metallic parts on the surface of the barn should be connected with the rod. The lower inside end should be connected with the earth. For example, a wind mill placed on top the barn should be connected with the lightning rods on the outside and grounded to the earth on the inside.

A barn, in fact all farm buildings, are inadequately protected from fire. Some type of a water supply system which would also furnish a supply for the house ought to be provided for fire protection. A tank placed in the haymow or a pressure tank located in a separate building would be cheap fire insurance.

STRENGTH IMPORTANT IN BARN FRAMING

The plank frame type of construction is most generally used at the present time. The old timber frame type of construction is too expensive with the present high cost of large timbers and the difficulty of securing them at the local lumber yards. Two inches is the thickest material used in plank frame type of construction. It is a distinct advantage to use the plank frame type of construction for it saves in the cost of lumber, is more easily handled, takes less time to construct, and requires less skilled labor in framing the barn.

Either horizontal or vertical siding can be used. Drop siding or shiplap is ordinarily used for horizontal siding and 1x10 inch boards with three inch battens placed over the cracks for vertical siding. In this climate if the basement is not built of stone or concrete it should be lined on the inside with flooring or ceiling.

MORE HAY MOW ROOM UNDER A GAMBREL ROOF

There are two general types of barn roofs, the gable and gambrel. Many times the latter is called incorrectly the "hip" roof. The advantage of the gambrel over the gable roof is that increased hay room can be secured without building the barn any higher either at the plate or ridge.

The height of the gambrel roof should be equal to the width of half the building. The first rafter should have a rise of one-third the width of the building and a run of one-sixth. The second should have a run of one-third the width of the building and a rise of one-sixth. Then in the case of a 36 foot barn the lower rafter would have a rise of 12 feet and a run of 6 feet, the second rafter a run of 12 feet and a rise of 6 feet.

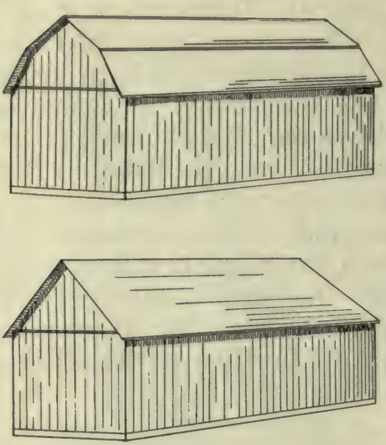


FIG. 17.—GAMBREL AND GABLE ROOFS

The hay mow is increased in size in a gambrel roof barn without increasing the height of the roof at the plate or ridge.

END BRACE ADDS STRENGTH

The end brace shown at A in Figure 18 is designed to prevent any end racking of the barn as well as to prevent the end of the barn from springing. Many plank frame barns constructed without this brace are likely to spring out at the end, in some instances, as far as from two to six inches. As there is no other truss work or ties bracing the end of the barn, it is very desirable that the end brace be built in a barn of the plank frame type of construction.

USE CARE IN MAKING CONCRETE

Concrete is the best home-made product that can be used as barn building material. In many parts of the state sand and gravel for concrete work can be found very near the structure in which it is to be used. Concrete can be used to a decided advantage for walls, mangers, floors, gutters.

In selecting the material for such work the sand and gravel should be clean and free from loam, the presence of which prevents a good bond being secured between the sand and cement and gravel and eventually causes the structure to crumble. The best concrete results from properly graded materials. As sand and gravel are ordinarily found in the average gravel bank, there is an excess of sand. It should

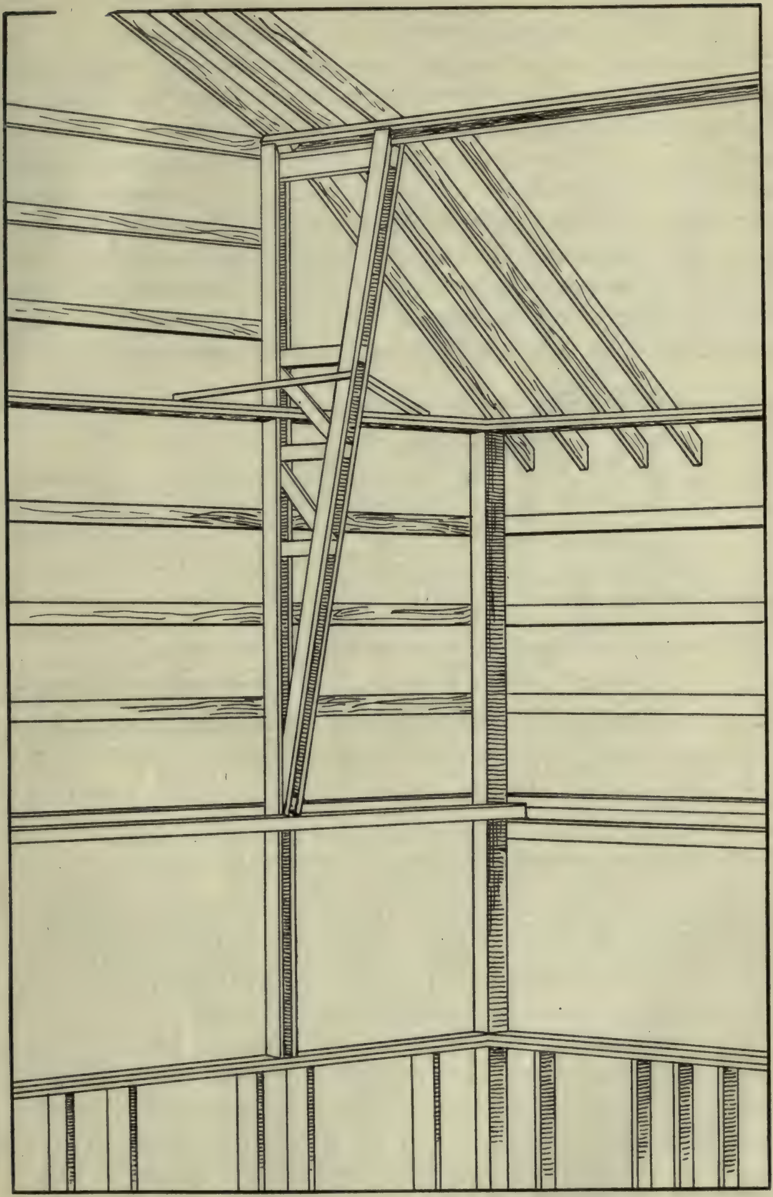


FIG. 18.—THE END BRACE ADDS STRENGTH

In some plank frame barns the ends often bulge out. The end brace prevents this at a very slight additional cost.

be in proportion of one part of sand to two parts of stone. Ordinarily it is found in just the opposite proportion.

To obtain the strongest concrete with the minimum amount of cement it is very important that the cement, sand and gravel be properly proportioned. If bank-run gravel is to be used and the mixture is in the proportion of one part sand to two parts stone, a mixture of one part cement to five parts of bank-run gravel would be sufficiently strong for the walls and basement floors. For a reinforced concrete hay mow floor, however, a mixture of one part cement to four parts of gravel (1–4), should be used, together with the proper amount of reinforcement. If the sand and gravel are separate, a good mixture to use for a wall is one part cement, two and a half parts sand, and five parts stone or gravel (1:2½:5), and a one, two, four (1:2:4) mixture in the hay-mow floor where reinforcement is neccessary.

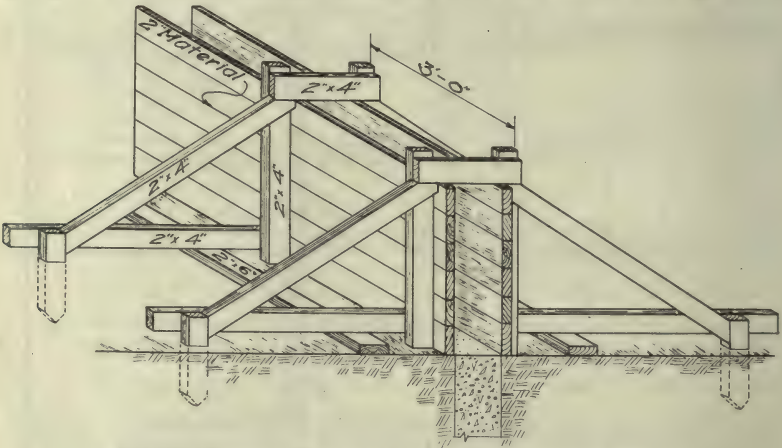
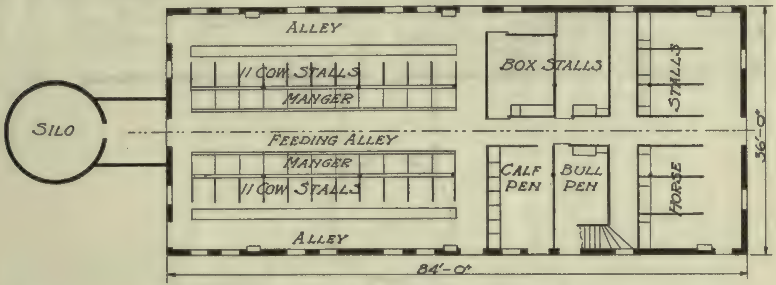


FIG. 19.—A FORM FOR BUILDING A CONCRETE WALL
In building a concrete wall much depends upon having the bracing in the form of sufficient strength and properly spaced.

Another essential for good concrete is proper mixing. The entire mass should be so thoroughly mixed before water is added that it will be of uniform color. Enough water should then be added so that it will be of a rather sluggish consistency. If too much water is added there is danger of separating the particles in the process of placing, or of the heavy stones sinking to the bottom and the cement and fine sand coming to the top. No rocks larger than one-third of the thickness of the wall should be placed in the center and puddled down into the mass of concrete. If a smooth finish is desired on the wall, a flat spade should be worked up and down the sides working to the outside some of the finer materials while the larger materials are pushed back.

A form for building a concrete wall requires good bracing and judicious spacing of braces. Figure 19 shows the detail construction of a form for building from a three to a nine foot concrete wall.

In continuing the placing of new concrete on a previous day's work the old concrete should be thoroughly wet first and then sprinkled with fresh cement and the first concrete placed should consist of finer materials thoroughly tamped so that a good bond will be secured between the old and the new concrete. It is advisable to keep concrete covered during hot weather and to keep it well sprinkled for three or four days.

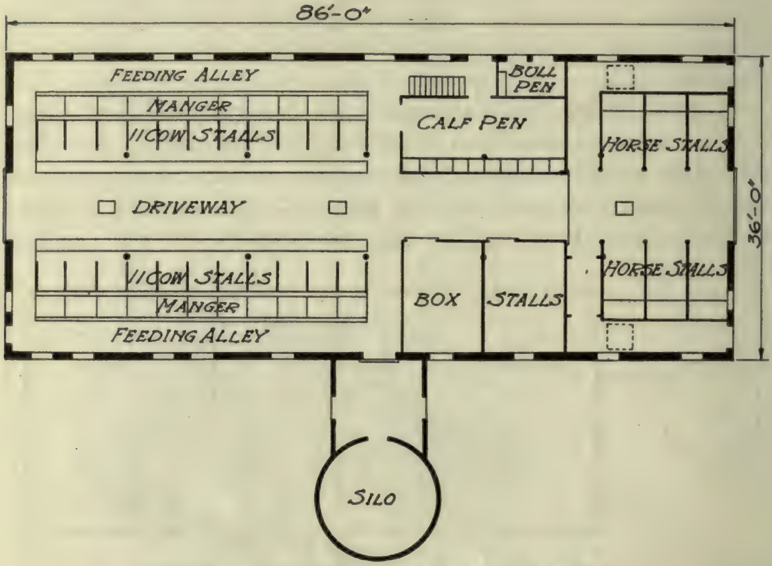


PLAN NO. 1—GENERAL PURPOSE BARN

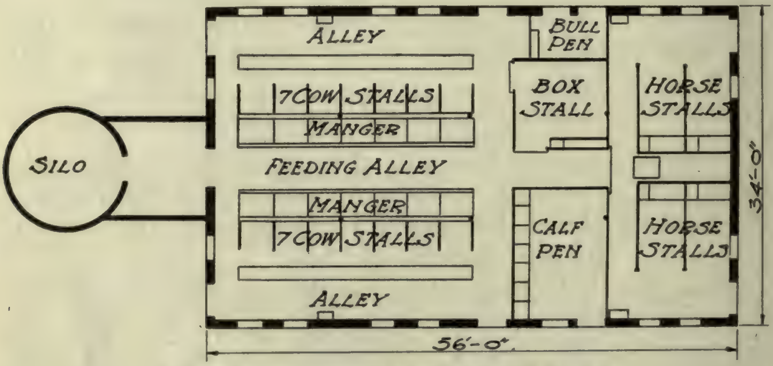
AVAILABLE FARM BARN PLANS

Detailed drawings and bills of material for the following barns may be secured from the Department of Agricultural Engineering of the University of Wisconsin, Madison, in accordance with the following schedule:

Plan No. 1—General Purpose Barn.—This general purpose barn is 36 feet wide and 84 feet long and in planned to accommodate 22 head of cattle and six horses. It also contains a calf pen, a bull pen and two box stalls. The cows face in and the silo is placed at the end of the central feedingalley. The horse barn is separated from the cow barn by sliding doors. The barn loft is divided into six bents of 14 feet each. Hay is elevated into the barn from the outside and feed bins are provided on the second floor. The feed room and silage room are combined. A root cellar is provided just below the feed room. The drawings consist of a floor plan, elevations, cross sections showing all framing details. Price (for postage and blue printing) 20 cents.

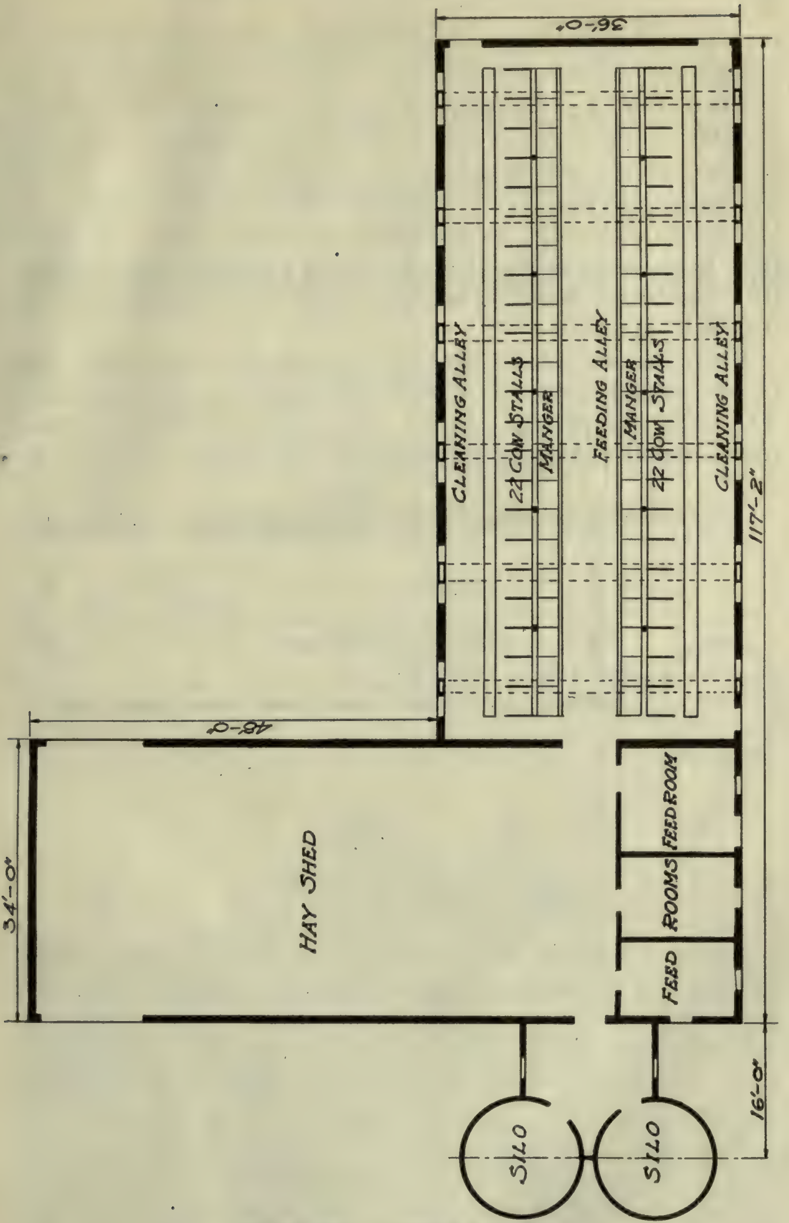


PLAN NO. 2—GENERAL PURPOSE BARN



PLAN NO. 3—GENERAL PURPOSE BARN

Plan No. 2—General Purpose Barn.—In this general purpose barn which is 36 feet wide and 86 feet long the cows face out. In all other respects it is essentially the same as Plan No. 1. The silo has been placed at one side of barn in order to permit a driveway through the center. The draw-

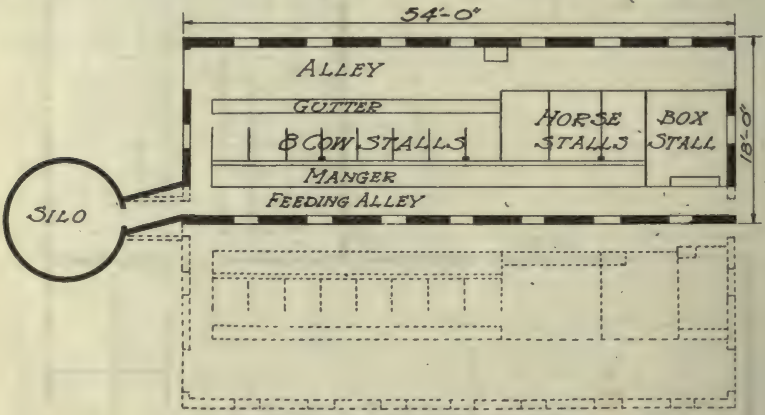


PLAN NO. 4—DAIRY BARN

ings consist of floor plan, elevations, cross sections and framing details. Price (for postage and blue printing) 20 cents.

Plan No. 3.—General Purpose Barn.—This general purpose dairy barn (34 feet x 56 feet) is designed to meet the needs of the farmer on about an 80 to 120 acre farm. It will accommodate four head of horses and 14 head of cattle. It also contains a calf pen, a bull pen and a box stall. The cows face the center aisle. The drawings consist of floor plans, framing details and elevations. Price (for postage and blue printing) 20 cents.

Plan No. 4.—Dairy Barn.—This shows a one story type of barn with hay shed and feed room placed on the north side. The floor plan provides for 44 cows and except that no room for horses is provided is practically the same so far as arrangement is concerned, as that of No. 1. This type of construction is somewhat cheaper than the regular two story barn and permits of expansion at a lower cost without the waste storage space. Floor plans, framing details and elevations can be furnished. Price (for postage and blue printing) 20 cents.



PLAN NO. 5—PIONEER BARN

Plan No. 5.—Pioneer Barn.—This pioneer barn is 18 feet wide and 56 feet long, and is designed for the settler farmer. It is planned so that the barn can be added to easily and eventually be 36 feet wide and hold just double the present capacity of eight cows, three single horse stalls, one double stall and one box stall. Floor plans and framing details can be furnished. Price (for postage and blue printing) 10 cents.

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By L. W. Chase.

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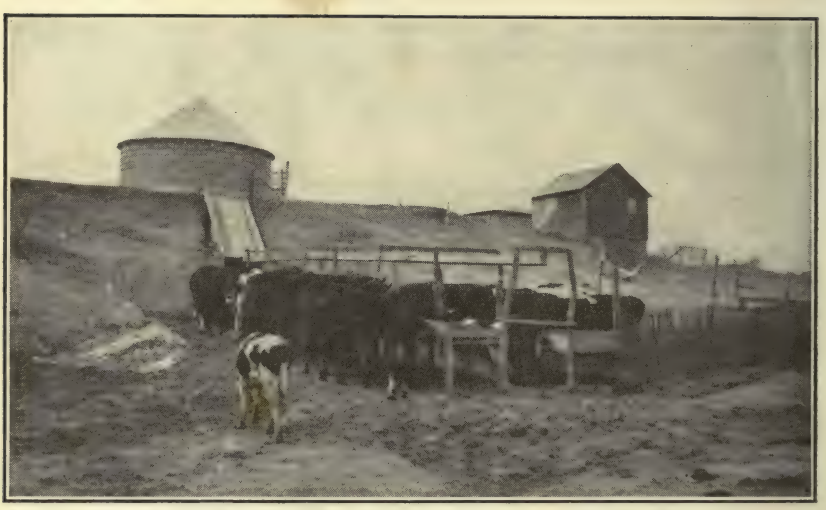

THE BANK SILO OF PETER BERGQUIST, ATLANTA, NEBRASKA.

Doors are provided up and down the side of the silo opposite the passage, so the silage can be thrown from the silo into the common litter carrier which runs out over the feed bunks, as shown in the cut.

SILO CONSTRUCTION IN NEBRASKA.

BY L. W. CHASE.

INTRODUCTION.

This bulletin discusses briefly some of the types of silos which are being erected in Nebraska at the present time.

A very much more complete bulletin on this subject, under the same title and the same number, is being published for distribution on application. This bulletin gives the details for the erection of the different types of silos. Those desiring to secure a copy of the same should ask for "**Limited Edition**" of bulletin on Silo Construction in Nebraska, No. 138.

FORM OF SILO.

Experience has shown that the best form for a silo is round with the walls perpendicular. The round silo does away with corners in which silage is likely to spoil. It gives the largest capacity for the amount of material in the walls, and where built above ground this form of construction resists the winds and the pressure of silage from within better than the square silo.

SIZE OF SILOS.

When the silo exceeds 16 feet in diameter, it requires more work to get the silage to the door than in the smaller silo. It also requires a larger amount to be fed daily in order to keep the silage from spoiling on account of its contact with the air. A silo of large diameter and not very tall has more spoiled silage in it per ton of good silage than a silo of greater height. The pressure on the silage is measured by the height of the silo and not by its diameter, so that the tall, slim silo will hold practically as much silage per square foot of wall surface as the short, broad one. On account of this greater capacity of tall silos, it is seldom advisable to build one less than 30 feet in height. Where built of masonry, or where well anchored and carefully looked after, they may economically be built higher, to give the needed capacity without getting the silo unduly large in diameter.

In pit silos the diameter may be somewhat greater in proportion to the height. The box used in hoisting the silage can be dropped into any part of the silo where it is convenient to fill, and the heaviest part of the silage being at the bottom it is well to reduce the cost of hoisting the silage by making the silo as shallow as can reasonably be done and secure a good quality of silage. In this case, additional capacity may be secured by additional diameter, provided the surface exposed is not so great as to affect the quality of the silage as it is being fed. Even with pit silos, it is doubtful if they should be built less than 24 feet in height. If this height cannot be secured below ground without difficulty, a part of it can be built above ground, in this way easily securing the height of silo which is necessary to give capacity and a good quality of silage, and not requiring expensive machinery for filling.

CAPACITY OF SILOS.

TABLE 1.—*Rate of feeding from silos of different diameters.*

Diameter, in feet	Approximate minimum pounds to be fed daily		* Number of different kinds of stock to keep the silage in summer from spoiling					
	Summer	Winter	Horses	500-lb. calves	Stock cattle	Beef cattle	Dairy cattle	Sheep
10	525	263	48	44	26	21	13	175
12	755	378	69	63	38	30	19	252
14	1,030	515	94	86	52	41	26	344
16	1,340	670	122	112	67	54	34	446
18	1,700	850	155	142	85	68	42	567
20	2,100	1,050	191	175	105	84	53	700

* If the silo is to be used for winter feeding only, it will require only one-half as many of each kind of stock to keep the silage in good condition as where it is used for summer feeding.

TABLE 2.—*Capacity of round silos in tons.*
(From King's Tables.)

Inside height of silo, in feet	Inside diameter of silo, in feet					
	10	12	14	16	18	20
20	26	38	51	67	85	105
24	34	49	66	87	110	135
26	37	55	75	98	123	154
28	42	61	83	108	136	169
30	47	67	92	119	151	186
32	51	74	100	131	166	205
34	56	80	109	143	181	224
36	..	87	119	155	196	242
38	..	94	128	169	213	261
40	..	101	138	180	229	282
44	..	...	172	208	264	325
48	..	...	...	...	299	368

ESSENTIALS OF A WELL-DESIGNED SILO.

The essential features of a well-designed silo can be summed up briefly as follows:

1. The walls should be practically air-tight.

2. The inner surfaces of the wall should be smooth and perpendicular.

3. The inner surfaces of the walls should be free from corners. Round silos are more efficient and economical than other types.

4. The walls should be sufficiently non-conducting to prevent excessive freezing,—especially so when the silage is to be fed during cold weather.

5. The walls should be sufficiently firm or sufficiently well anchored to prevent cracking due to settling or racking due to wind.

6. The doors should be so designed that a minimum amount of silage has to be removed before they can be opened.

7. A good ladder should be provided with steps from 15 inches to 18 inches apart and at least 3½ inches away from the silo or walls of the chute.

8. The foundation should be heavy, well made, and reach below the frost line.

9. A good roof makes the silo more durable, adds greatly to its appearance, and if tight assists materially in keeping the silage from freezing.

Silos which have the above features will be found convenient, cause little trouble, and, when properly filled, will keep the silage in perfect condition.

TYPES OF SILOS.

1. Pit silos, built partially or wholly below ground.

2. Silos above ground, built of wood or of masonry.

The stave silo is the most common of the wood type in Nebraska.

The masonry silo is commonly built of:

- Concrete hollow blocks.
- Clay blocks or hollow brick.
- Solid concrete poured into a form, sometimes called the "monolithic silo."
- Concrete plastered on metal lath.

All masonry silos should be reinforced with steel, and when so reinforced are the most permanent and most economical form of above-ground construction.

WOOD SILOS.

Wood silos in various forms are used thruout the East, but in Nebraska the wood stave silo seems more popular, altho during the past year the wood silo known as the "crib silo" has been introduced and is receiving considerable attention.

STAVE SILOS.

There are three general types of stave silos: the homemade plain stave, the homemade tongued and grooved, and the manufactured tongued and grooved.

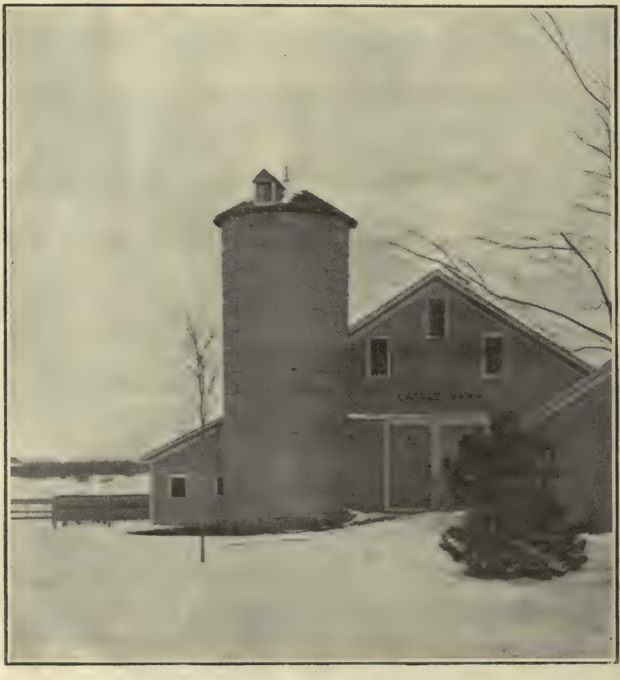

Fig. 1. Single-piece fir stave silo at Beef Cattle Barn, University Farm, Lincoln, Nebr.

The first type mentioned is somewhat cheaper than the other types, but it does not seem possible to hold silos in shape without tongued and grooved staves. Probably this is due to the fact that in the summer when the silos are empty the air gets on all sides of the staves and causes them to dry out much faster and to warp as they dry.

The second type of silo is as strong as any stave silo and as easily cared for, but is more trouble to order. The third type should also have more convenient doors.

SILO WOODS.

Silos have not been in use long enough in Nebraska to warrant the drawing of any definite conclusion as to lasting qualities. Two white pine, homemade, plain, stave silos examined near Omaha after having been used eight years were very badly decayed at the lower ends of the staves. A cheap white pine silo on the University Farm was practically rotted out at the end of five years' use, while a better grade of white pine silo which has been in use about eight and one-half years has just commenced to decay at the lower ends of the staves and is apparently in good condition above the first foot.

Conclusions drawn from Bulletin No. 100, Iowa State College, place the merits of woods for silo use as follows:

1, Redwood; 2, Cypress; 3, Oregon Fir; 4, Tamarack; 5, White Pine; 6, Long-leaf Yellow Pine.

ORDERING STAVE SILOS.

The Manufactured Silo.—In ordering a silo it must be borne in mind that the custom of silo manufacturers is to sell only the silo proper with the necessary anchor rods and also the rafters for the roofs. In order to complete the silo, the following materials are needed: Silo floor, foundation wall, sheathing, roofing, paint, and chute.

THE HOMEMADE TONGUED AND GROOVED STAVE SILO.

This silo needs all the material mentioned in the preceding paragraph under ordering "The Manufactured Silo," and in addition needs the material for the silo proper with the anchors and rafters. A silo 16 by 30 feet purchased in this way should not cost more than $260.00 for the material used in the floor, foundation, walls, and roof, including the paint.

FOUNDATIONS.

The foundation for a silo is an important part which is often overlooked. It can be made of brick, clay blocks, concrete blocks, or solid concrete. Probably the latter is as good as any of the others and less difficult to handle. All foundations should go below the frost line.

If the foundation is to hold a masonry silo, it should have a footing at least two feet wide and 18 inches deep, while if it supports a wooden silo, the wall should be from 10 inches to 12 inches wide with no special footing. When the staves are set on the foundation, they should be kept back at least five inches from the inside of the wall and tied well with anchors which have been previously set in the foundation.

ERECTING THE SILO.

The best staging for erecting silos is made by building a single post cage around the silo foundation, and on this erecting walks upon which the men may work while setting up the staves and placing the hoops.

The door frame or the door staves should be set up first and plumbed and stayed in at least three places. Staves can then be set up on each side of the door frame and attached to it by means of wet laths or barrel staves. Care must be exercised to keep the lower ends of the staves in a true circle and to keep the staves plumb.

All staves should be stapled to the hoops in two places and preferably three or more.

The anchors should be well set and protected from the rubbing of cattle.

A roof adds materially to the appearance of a silo, keeps the top silage from drying out, prevents storms blowing in, and assists in keeping the silage from freezing.

The chute is essential to prevent the silage blowing away as it is being thrown down. It should be about three feet square and contain one or two windows. A ladder nailed alongside the doors, but on the chute, is very convenient to use when entering the silo.

CARE OF STAVE SILOS.

This type of silo should be well painted. The hoops should be tightened two or three times during the summer and loosened while filling in the fall. All anchors should be kept tight at all times, and should the silo become out of plumb it should be straightened before being filled again.

SILOS UNDERGROUND, OR PIT SILOS.

Wherever a cheap silo is desired and the soil is of a uniform texture and free from all danger of seepage, a pit silo can be used to good advantage. Such silos can be built quite cheaply and require less expensive cutters and a smaller engine for filling, and there is no danger of the silage freezing when in the silo. The greatest disadvantage in such silos is the inconvenience in removing the silage.

When silage ferments, which is during the first two weeks that it is in the silo, carbon dioxide gas is thrown off. This gas is heavier than air and is transparent. As it is heavier than air, it settles to the lowest place and stays there unless carried away by air currents or some other means. As a consequence, if the silo is partly filled and left standing a few days there is danger of enough gas accumulating in the silo to suffocate people. As a precaution it is always well to start the cutter and let it run five or ten minutes before anyone enters the silo. If the silo is open, so that the wind currents can blow into the top of it, these currents will carry away all the poisonous gases so that there will be no danger.

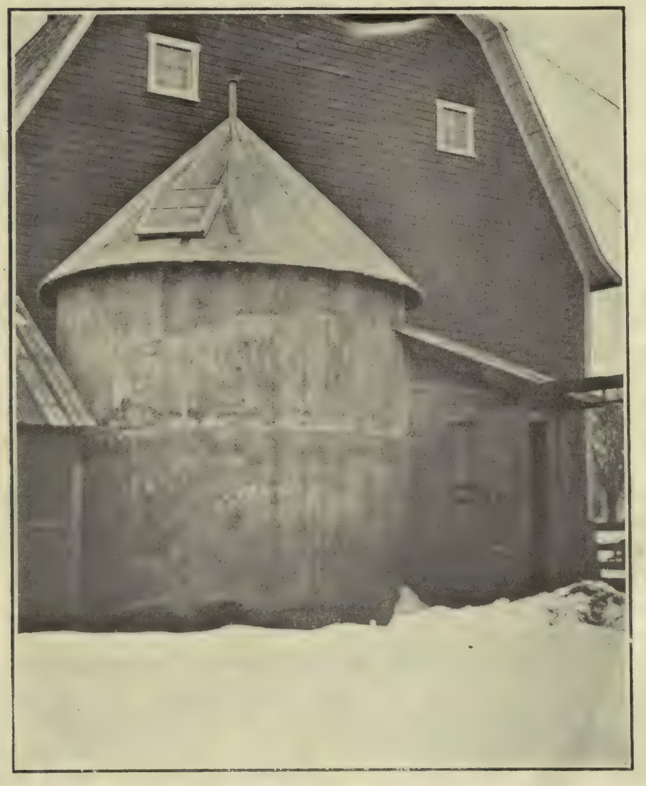

Fig. 2. Semi-pit silo on Chase Farm, Pawnee City, Nebr.

In the winter time when the silo is being used there is no danger, because the gas does not form in quantities at that time, and furthermore the air in the silo is warmer than the outside air, hence air currents are set up which carry the gases away.

TYPES OF PIT SILOS.

There are three types of pit silos: (1) The plain hole in the ground which very much resembles a dug well without any curbing; (2) the semi-pit silo which has a part of the silo above ground and a part located in the ground; and (3) the bank silo, which is a silo either located on the bank in such a way that by tunneling in at the bottom a chute can be made up along the silo similar to that of a silo which sets above ground, or where the silo sits so close to the bank that the silage can simply be thrown out at the doors and permitted to drop to the ground. Probably this last type of silo is the most convenient and inexpensive and most satisfactory of any silo that can be constructed.

CONSTRUCTING PIT SILOS.

The pit silo is built down instead of up. The first operation is to dig a trench around the top which has an inside diameter the same as the inside diameter of the silo. This trench should be as narrow as can be conveniently dug with a spade and as deep as the spade will conveniently reach. Fill the trench with concrete and when it has set remove the dirt from inside, down to a depth of about six feet.

When this depth is reached, the silo walls should be plastered. A mixture of one part of cement to two and one-half parts of screened sand is the best proportion for the plaster. Layers should be plastered on until the coat of plaster is about three-quarters of an inch thick or more. It will take two or three coats to do this.

After the first section of the silo has been plastered, then take out about six feet more of earth and plaster this in the same manner. Continue this process until the proper depth is reached.

By digging and plastering a silo in this manner there is no need of staging, and one has a good strong floor upon which to work.

When the bottom of the silo is reached, the floor can be put in if desired. However, it is not material whether the silo has a floor or not.

If a part of the silo is to be built above the ground, it can be built before the dirt is thrown out, or afterwards, depending upon the convenience of the farmer.

There are three ways to build that part of the silo which is above ground. One is to make a form and build it of solid concrete, another is to build it of cement blocks, and the third is to set up metal lath on the foundation and plaster concrete onto the inside and outside of this. It is always well to have pit silos about three feet above ground, as this obviates danger of stock falling into them.

The device used by most people for removing the earth is either half barrels fixed up in the form of buckets, or boxes with a trip in the bottom so that the bottom will drop down. These boxes are suspended from a hay carrier car and track which in turn is supported by pole tripods.

If the ground is not of a uniform texture, it is generally better to wall a pit silo with some heavier material than plaster. To do this, metal lath can be tacked onto the ground and concrete plastered onto this, or a form can be built and a concrete wall erected, or one can use brick.

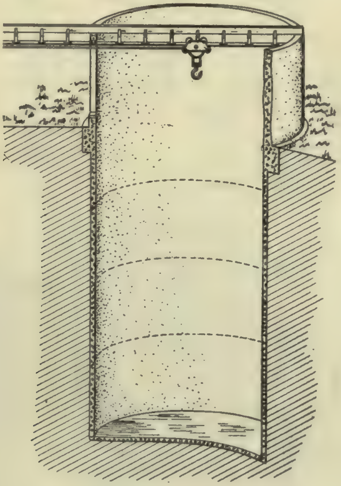

Fig. 3. Illustrating the various stages of excavation of semi-pit silo.

REMOVING THE SILAGE.

There are three or four schemes in use for removing the silage from pit silos. One is by hoisting it hand over hand in baskets or buckets, another is by dropping a box into the silo thru an opening in the roof and hoisting out by means of a hay fork car and track, while a third method is to arrange a hoisting device similar to the hoisting device used in the country store elevator.

COST OF PIT SILOS.

Name, address, and conditions	Size, in feet	Cost		
		Total	Per ton	
			Total	Less home labor
M. C. Anderson, Cushing, Nebr. (without roof)	14x27	$60.15	$0.76	$0.194
W. P. Bennett, Cambridge, Nebr. (complete with hoisting device)	16x30	146.85	1.23	.555
Chase Farm, Pawnee City, Nebr. (12 feet above ground and complete)	12x33½	200.75	2.57	.910
Larger silo estimated on M. C. Anderson's silo as a basis	16x30	84.75	.71	.159

CONCRETE BLOCK SILO.

There are many localities where the cement block silo will be more advisable than any other type. In a community where only one man expects to build a silo and where it is not too expensive to obtain sand, probably such a silo will be cheaper and easier to erect than solid concrete or clay block silos. If properly constructed they are as good as any silo and no doubt have a more pleasing architectural effect than any other type. It is a simple matter to make the blocks and they are easily laid.

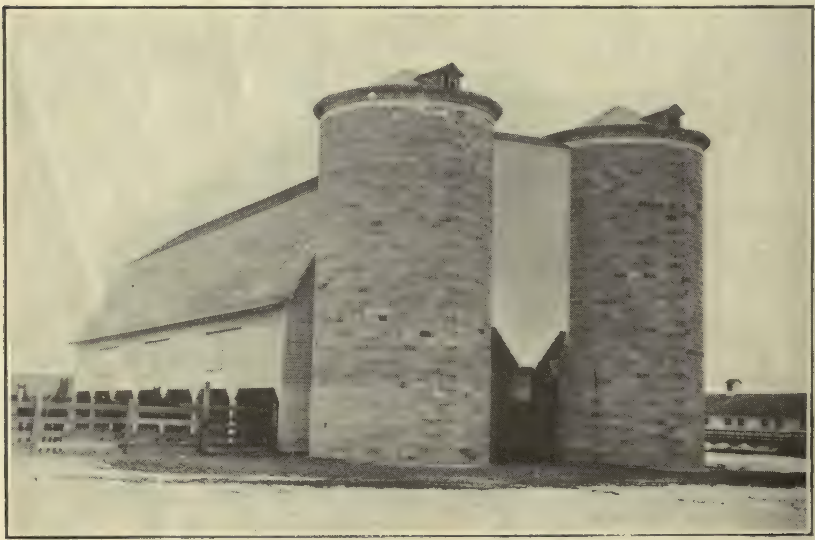

Fig. 4. Homemade concrete block silos on R. B. Schneider's farm, Fremont, Nebr.

LAYING THE WALLS.

Between each two courses of blocks in the mortar joint, a steel reinforcing bar is laid. This bar is preferably made of No. 3 hard wire. However, it can be made of two No. 9 wires or one No. 6 wire and a smaller wire. There should be reinforcing at each motar joint.

The doors are either of the intermittent type or of the continuous type. The intermittent type is much more easily constructed tho not quite as convenient as the continuous type.

The door frames must be well reinforced with heavy steel bars. These bars stand up and down on either side of the door with other bars running across between the doors. The bars which lie in the mortar joint either hook around the vertical rods adjacent to the door or pass thru the mortar joints between the doors.

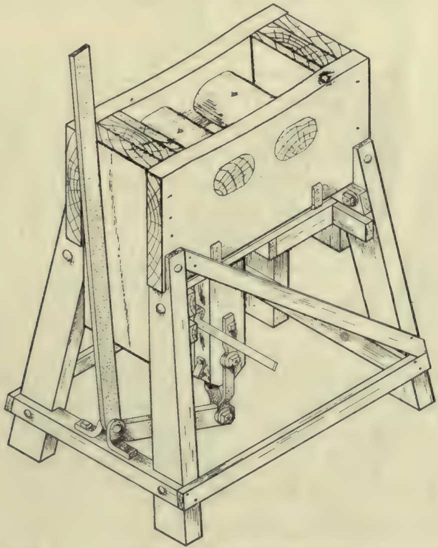

Fig. 5. Homemade single-piece concrete block machine.

BLOCKS.

The blocks for concrete silos can be of almost any type or form. Solid blocks can be used, but are very heavy and troublesome to handle. Straight-faced commercial blocks will make good silos. However, the silo must be plastered on the inside. Commercial blocks with curved faces make good silos, tho they are generally so porous that they should be plastered on the inside or at least should be washed with a good coat of pure cement.

The Department of Agricultural Engineering has devised a homemade machine for making cement blocks. There are two types of this machine,—one for making a two-piece block, which makes an almost continuous air-space between the inside and outside walls of the silo, and the other machine (fig. 5), which makes a one-piece hollow block similar to the commercial block excepting that it is so constructed that the inside face of the block is troweled. By troweling the face of this block it is made waterproof and smooth; hence the silo will not need to be washed with cement, nor will it need to be plastered on the inside.

This machine can also be used for making foundations for barns and houses, or for making hog houses, poultry houses, or anything in the cement block line that is needed.

SCAFFOLD.

The scaffold for block silos can be built on either the inside or the outside of the silo. If it is built on the inside, it should be constructed with four posts and a platform, the platform being one which will move up and down at the discretion of the operator, a good grade of wire stretcher being used to raise the platform. This type of scaffold was devised by the Agricultural Engineering department of the Iowa State College and used by them extensively and has proved very successful. It has also been used in erecting several silos in Nebraska, and has proved very efficient.

ROOFS.

Cement block silos as well as clay block silos and solid concrete silos should have concrete roofs. A concrete roof is much more durable than a shingle roof, is generally tighter, and prevents the freezing of the silage to a great extent, and is no more expensive than a good shingle roof.

COST OF CONCRETE BLOCK SILOS.

Name, address, and conditions	Size, in feet	Cost			
		Total	Less home labor	Per ton	
				Total	Less home labor
A. Armen, Martell, Nebr. without roof and chute)	16 x32	$415.10	$242.85	$3.19	$1.87
R. B. Schneider, Fremont, Nebr. (concrete roof, but without chute)	16 x37½	658.78	444.16	3.94	2.79
R. B. Schneider, Fremont, Nebr. (concrete roof, but without chute)	16 x37½	600.36	416.69	3.59	2.49
E. M. Little, Silver Creek, Nebr. (without roof, hauling, and board)	14½x32	206.48	172.48	1.93	1.61
R. S. Cleary, North Loup, Nebr. (without chute for silo and board for men)	16 x30	331.00	.....	....	....

CLAY BLOCK SILOS.

Clay block or square tile or hollow brick silos have been used more or less in Ohio for several years. A few years ago the Department of Agricultural Engineering at Iowa State College devised a scheme whereby these blocks could be used in common silo construction by simply reinforcing the common blocks, the reinforcing being placed in the mortar joints similar to the suggestion made relative to reinforcing concrete blocks. These silos are permanent as regards material, are not hard to construct, cost about the same as a concrete block silo, have a dead air space which should prevent freezing to a large extent, and as a whole are considered excellent.

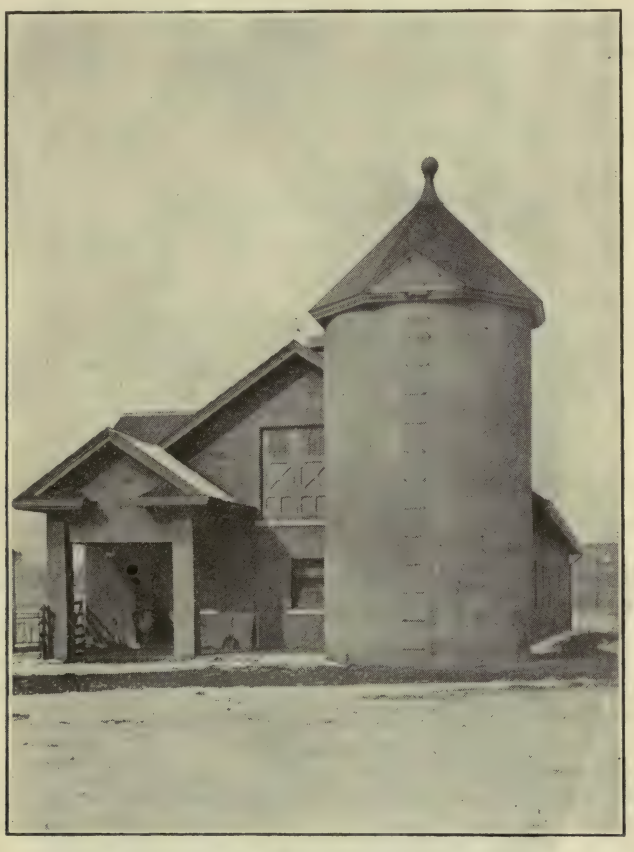

Fig. 6. Clay block silo at the Steer Feeding plant, University Farm, Lincoln, Nebr.

At present there is nobody in the state of Nebraska manufacturing especially burned clay blocks for silos of this nature. The common block must be plastered on the inside and outside to make it permanent or blocks which are hard burned and do not need to be plastered inside and out as common blocks do must be ordered from other states.

The choice between this silo and the concrete block silo lies largely in the freight rates and in the price for clay blocks, sand, and cement.

COST OF CLAY BLOCK SILOS.

Name, address, and conditions	Size, in feet	Cost			
		Total	Less home labor	Per ton	
				Total	Less home labor
University Farm, Lincoln, Nebr. (without roof and chute)	16x31½	$451.20	......	....	....
F. P. Tipton, Seward, Nebr. (without plaster, roof, and chute)	16x35	330.50	$278.10	$2.21	$1.88
W. R. Mansfield, Wisner, Nebr.	20x47	607.85	489.00	1.70	1.37

SOLID CONCRETE SILOS.

During the past summer, the Department of Agricultural Engineering has supervised the erection of four solid concrete silos. Three of these were erected with a form made by the Department, while one was erected with a form that was made on the ground where the silo was built.

These silos require the same type of foundation that the concrete block silos do, and should have a concrete roof, and it is also well to have a concrete chute, as it costs very little more than a good frame chute.

FORMS.

The forms for erecting the walls are preferably made by building up an inside framework of wood which is covered with one-inch material. If the forms are to be used on more than one silo, they should be covered with galvanized iron.

The wood forms are erected in four sections and held together with bolted cleats which permit the form to shrink up so that it can be taken away from the concrete when desired and then raised.

The outside form is made of a heavier grade of galvanized iron and riveted together into either two or four sections as desired. These sections are held together by means of bolts, which permit them to draw up or expand.

The forms should be made about four feet high. This will permit of about a day's work in filling and raising. The form is filled one day, raised the next morning and filled, and then allowed to set until the next day, when it is raised and filled again.

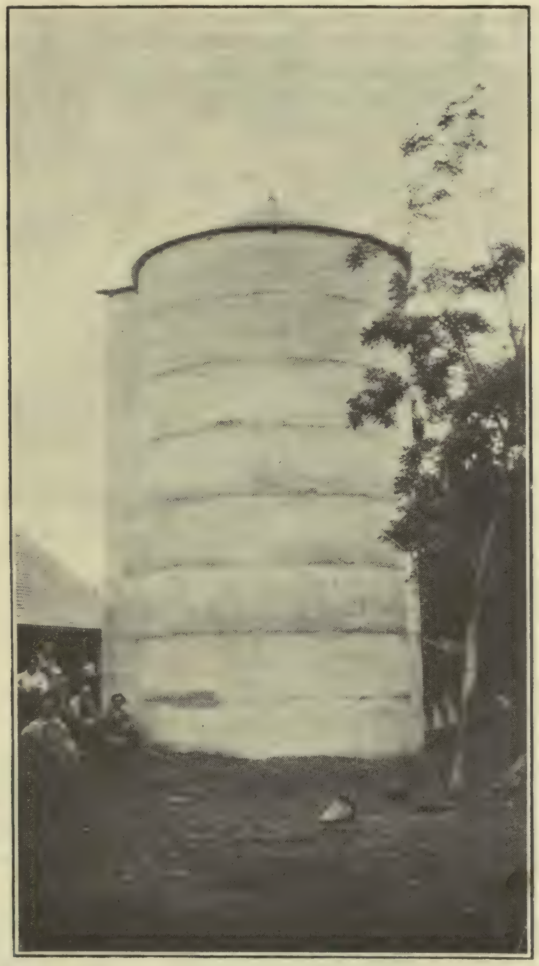

Fig. 7. Solid concrete silo on Bert Mapes' farm, Norfolk, Nebr.

REINFORCEMENT.

The reinforcement for concrete silos can be of a heavy grade of woven wire, metal lath, or ordinary smooth wire tied to a few vertical rods. If such reinforcing is used, No. 3 hard wire is preferable.

DOORS.

The doors can be either continuous or intermittent. Either one is easy to make and very convenient for use. By using one's ingenuity, hinge doors can also be used on concrete silos. Details for silo doors are shown in our extended bulletin on "Silo Construction in Nebraska," No. 138.

COST OF SOLID CONCRETE SILOS.

Name, address, and conditions	Size, in feet	Cost			
		Total	Less home labor	Per ton	
				Total	Less home labor
Geo. Hall, Alvo, Nebr. (includes concrete roof and chute, hauling, and board for men, but does not include the form)......................	16x42	$516.04	$319.92	$2.66	$1.65
Valentine Substation, Valentine, Nebr. (same as Hall's silo).............	16x30	506.68	......	4.25	....
Bert Mapes, Norfolk, Nebr. (same as Hall's silo)....................	16x34	579.24	439.84	4.09	3.09
W. A. Stacey, Davenport, Nebr. (includes concrete roof and chute, all hauling, board for men, and home-made form)................... (Form cost, $71.18.) (Scaffold, 51.43.)	14x38	558.50	301.90	3.48	2.36

OTHER SILOS.

There are several other types of silos which no doubt might be used to good advantage in Nebraska. However, their use is so recent that there has not been an opportunity to give them a thoro investigation. The three following types seem to be commendable for use in Nebraska:

The Common Sense silo, which is built with eight sides by using two by fours laid flat. This silo was first erected in Nebraska during the summer of 1912 and whether or not defects will develop as the silo becomes older cannot be stated.

The plastered silo, which is built of concrete plastered onto metal lath and reinforced with heavy wire. This silo seems to be giving good satisfaction in Kansas.

The third type is a plastered silo wherein the concrete is plastered into a metal lath that has a raised rib which stiffens the lath and reinforces the silo.

UNIVERSITY OF ILLINOIS

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BULLETIN NO. 143

ECONOMY OF THE ROUND DAIRY BARN

By WILBER J. FRASER

URBANA, ILLINOIS, FEBRUARY, 1910

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ECONOMY OF THE ROUND DAIRY BARN

FULL SPECIFICATIONS AND DETAILED COST AND CONSTRUCTION OF THE NEW SIXTY-FOOT CIRCULAR DAIRY BARN AT THE UNIVERSITY. SAVING OF ROUND OVER RECTANGULAR BARNS. NOTES ON SEVERAL ROUND BARNS ON DAIRY FARMS.*

BY W. J. FRASER, CHIEF IN DAIRY HUSBANDRY

The planning, construction, and arrangement of farm buildings do not usually receive the thought and study these subjects warrant. How many dairymen have compared a circular, 40-cow barn with the common rectangular building containing the same area? How many understand that the circular structure is much the stronger; that the rectangular form requires 22 percent more wall and foundation to enclose the same space; and that the cost of material is from 34 to 58 percent more for the rectangular building?

In a community in which everyone is engaged in the same occupation, one person is likely to copy from his neighbor without apparently giving a thought as to whether or not there is a better way.

In a district of Kane county, Illinois, a certain type of dairy barn is used by nearly everyone, while in the next county a distinctly different type prevails, and the dairy barns of another adjacent county differ from those of either of the former, simply because the early settlers of this particular locality came from an eastern state and started building the style of barn then common in Pennsylvania.

In a certain community in Ohio where a milk condensing factory is located, a large number of farmers have barns 36x60 feet, with an "L" the same size. The loft of the "L" is used for the storage of straw, and the cows run loose in the lower portion. These barns are all built on practically the same plan and are usually of the same size, and this is the only community known to the writer where this form of barn is used in this manner.

This tendency to imitate emphasizes the fact that men do not exercise sufficient originality. Because most barns are rectangular is no reason that this is the best and most economical form.

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*Special acknowledgment is made to Mr. H. E. Crouch and Mr. R. E. Brand for their assistance in working out the detailed data which are the bases for the economic comparisons of the round and rectangular barns made in this bulletin.

WHY MORE ROUND BARNS ARE NOT BUILT

In an early day when lumber was cheap, buildings were built of logs, or at least had heavy frames. Under these conditions, the rectangular barn was the one naturally used, and people have followed in the footsteps of their forefathers in continuing this form of barn. The result is that the economy and advantages of the round barn have apparently never been considered. This is because they are not obvious at first sight, and become fully apparent only after a detailed study of the construction. For these reasons, the rectangular form still continues to be built, altho it re-

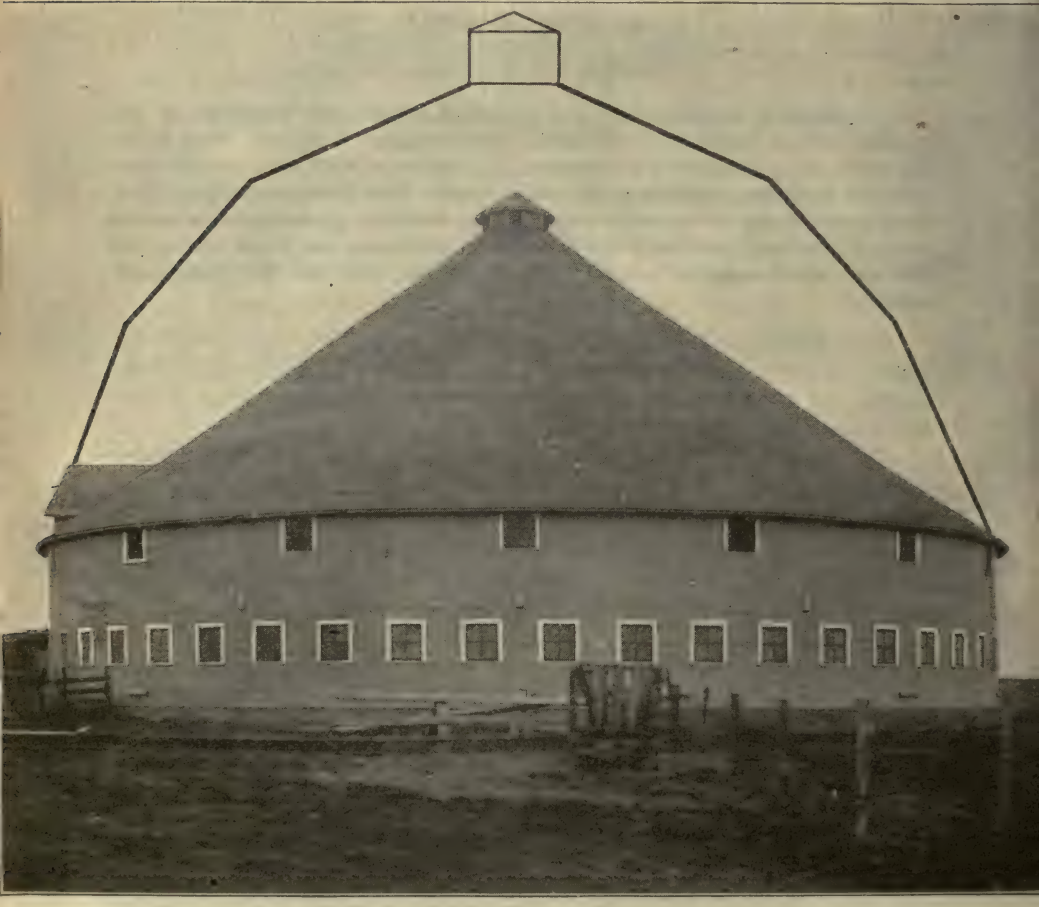

FIG. 1. BARN NO. 5. 100 FEET IN DIAMETER, SCALE 20 FEET TO ONE INCH; SHOWING INCREASED MOW CAPACITY GIVEN BY SELF-SUPPORTING ROOF.

quires much more lumber. As the price of lumber has advanced so materially in recent years, the possible saving in this material is a large item, and well worth investigating.

The objections to round barns have usually been made by those who have only a superficial knowledge of the subject, and do not really understand the relative merits of the two forms. To the writer's knowledge, there has never been published a carefully figured out, detailed comparison of a properly constructed circular barn with the rectangular barn.

The difficulty with most round barns that have been built, thus far, is that they do not have a self-supporting roof, and consequently lose many of the advantages of a properly constructed round barn. This is the principal reason why round barns have not become more popular. A straight roof necessarily requires many supports in the barn below. These are both costly and inconvenient, and make the roof no stronger than a dome-shaped, self-supporting roof which nearly doubles the capacity of the mow. See Fig. (1).

Many who have thus disregarded capacity have also wasted lumber and made a needless amount of work by chopping or hewing out the sill and plate, thus requiring more labor and lumber, besides sacrificing the greater strength of a built-up sill. Rightly constructed round barns are, however, being built to a limited extent. One contractor has erected twenty-four round barns, with self supporting roofs, in the last nine years. These barns vary in size from 40 feet in diameter with 18-foot posts to 102 feet in diameter with 30-foot posts.

Another reason for the scarcity of round barns is the difficulty in getting them built. Most carpenters hesitate to undertake the work because in the erection of a round barn the construction should be entirely different from that of the rectangular form. Many new problems present themselves, but when these are once understood, the round barn offers no more difficulties in construction than the rectangular form. It is, however, important to have a head carpenter who is accustomed to putting up round barns, as a man with ingenuity and experience can take advantage of many opportunities to save labor and material.

KIND OF BARN NEEDED

The first thing to consider in the erection of a barn is a convenient arrangement for the purpose for which it is to be used. At the University of Illinois, two years ago, a twenty-acre demonstration dairy farm was started, the sole object being to produce the largest amount of milk per acre at the least possible cost. To meet the requirements of a barn for this purpose, it became imperative to build one that was convenient for feeding and caring for the cows, economical of construction, and containing a large storage capacity in both silo and mow. These are the requirements of a barn for every practical dairyman.

A silo was needed that could be fed from the year round. With the small number of cows kept, a deep enough layer of silage could not be fed off each day to keep it good thru the summer, if the silo was more than 12 feet in diameter. As this small diameter was a necessity, it would require two silos 33 feet deep to supply enough silage. Two silos of such small diameter would not only be costly, but difficult to make stand, unless built of concrete. This difficulty was overcome by using the circular barn and placing in the center a silo which is 12 feet in diameter and 54 feet deep, thus making the one silo, with as much capacity as the two before mentioned, answer every purpose. This deep silo is an important part of the round barn, as it not only forms a support for the roof, but is protected by the barn, thus saving the cost of siding. Then, too, besides occupying the space least valuable for other purposes, it being centrally located, is in the most convenient place for feeding. The silage chute being open at the top forms a suction of air, which keeps the silage odor from the barn at milking time, and also assists in ventilation when the door to the chute is open.

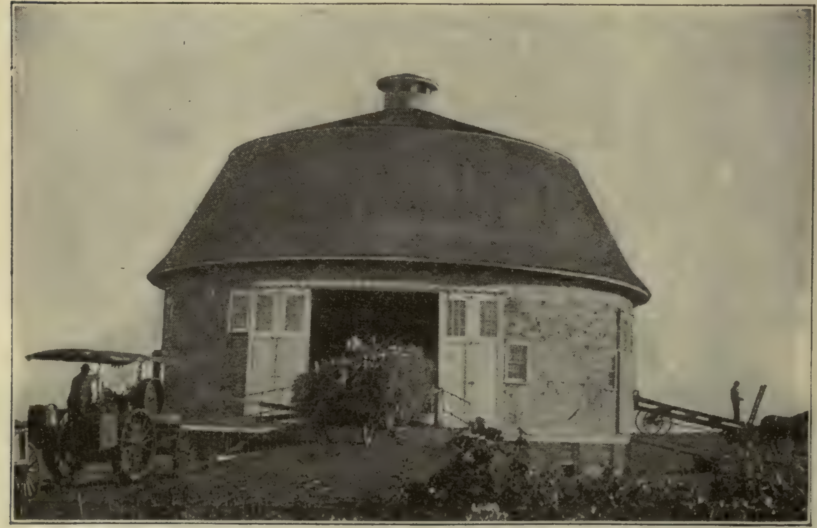

FIG. 2. FILLING THE SILO.

ADVANTAGES OF THE ROUND BARN

The points of superiority that the round dairy barn shows over the rectangular form are convenience, strength, and cheapness.

ROUND BARN MOST CONVENIENT

Considering that the barn on a dairy farm is used twice every day in the year, and that for six months each year the cows occupy it almost continuously, and that during this time a large amount of the labor of the farm is done inside the barn, it is evident that the question of its convenience is a vital one. The amount of time and strength wasted in useless labor in poorly arranged buildings is appalling. People do not stop to consider the saving in a year or a lifetime by having the barn so conveniently arranged that there is a saving of only a few seconds on each task that has to be done two or three times every day.

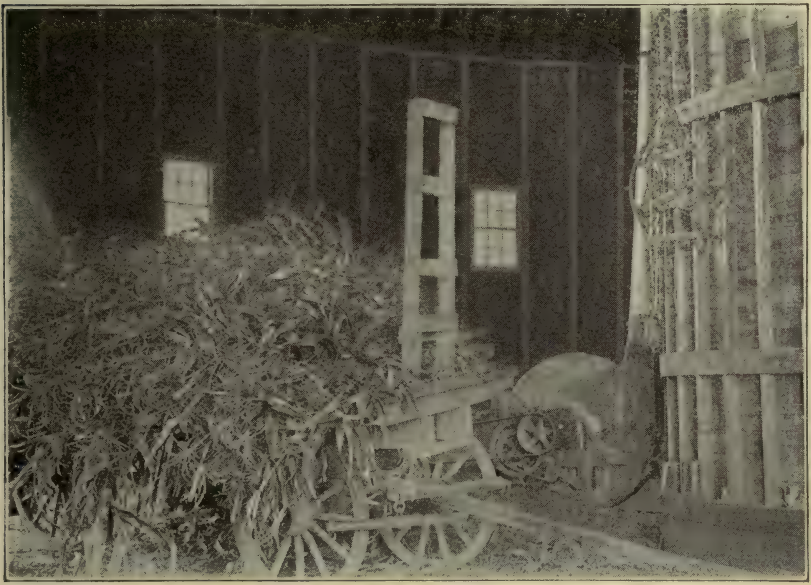

FIG. 3. INTERIOR OF BARN, SECOND FLOOR, SHOWING SILO AND LOCATION OF ENSILAGE CUTTER. (TEAM UNHITCHED TO SHOW CUTTER.)

The round barn has a special advantage in the work of distributing silage to the cows. The feeding commences at the chute where it is thrown down, and is continued around the circle, ending with the silage cart at the chute again, ready for the next feeding. The same thing is true in feeding hay and grain.

Still another great advantage is the large unobstructed hay mow. With the self-supporting roof, there are no timbers whatever obstructing the mow, which means no dragging of hay around posts or over girders. The hay carrier runs on a circular track around the mow, midway betwen the silo and the outside wall, and drops the hay at any desired point, thus in no case does the hay have to be moved but a few feet, which means a saving of much labor in the mowing.

To successfully embody all of the above discussed advantages in a dairy barn is one of the large problems in milk production. In a careful study of the barn question it soon became apparent that it was impossible to embody all of the requirements advantageously in anything but a circular form of building, and the 60-foot round barn, which is here described, was built.

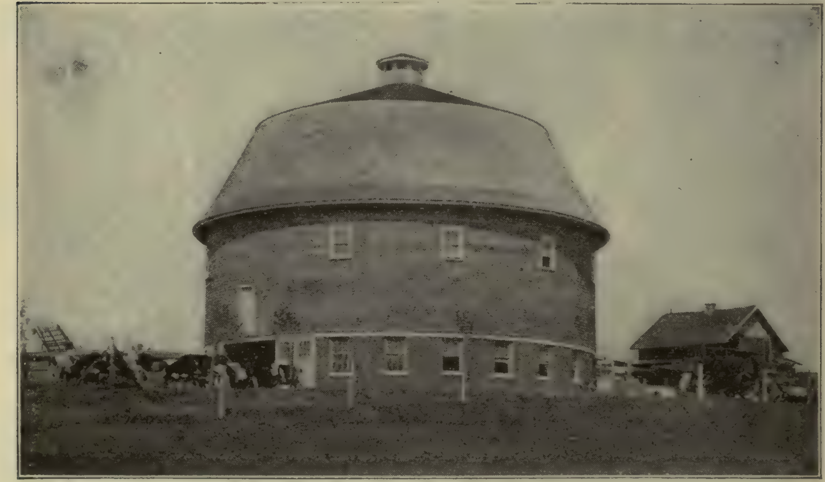

FIG. 4. SOUTH VIEW, SHOWING WELL LIGHTED STABLE.

CIRCULAR CONSTRUCTION THE STRONGEST

The circular construction is the strongest, because it takes advantage of the lineal, instead of the breaking strength of the lumber. Each row of boards running around the barn forms a hoop that holds the barn together A barrel, properly hooped and headed, is almost indestructible, and much stronger than a box, altho the hoops are small. This strength is because the stress comes on the hoops in a lineal direction. Any piece of timber is many times stronger on a lineal pull than on a breaking stress. Take for example a No. 1 yellow pine 2x6, 16 feet long, with an actual cross section of 1⅝x5⅝ inches. If placed on edge and supported at the ends, as a joist, the limit of safety for a load evenly distributed is 642 pounds, while the limit of safety for a load in the lineal direction of the same piece of timber is 12,800 pounds, or twenty times as great.

All exposed surfaces of a round barn are circular, as both the sides and roof are arched, which is the strongest form of construction to resist wind pressure; besides, the wind, in striking it, glances off and can get no direct hold on the walls or roof, as it can on the flat sides or gable ends of a rectangular structure. If the lumber is properly placed in a round barn, much of it will perform two or more functions. Every row of siding boards running around the building serves also as a brace, and the same is true of the roof boards and the arched rafters. If the siding is put on vertically and the roof built dome shaped, no scaffolding is required inside or out. These are points of economy in the round construction.

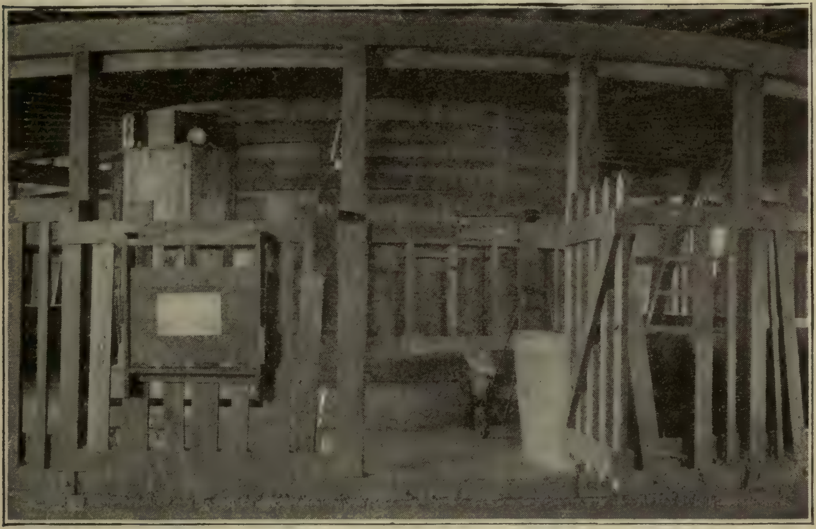

FIG. 5. IN COW STABLE, SHOWING SILO AND FEED ALLEY IN CENTER OF BARN; STANCHIONS ON RIGHT, MILK SCALES AND RECORD SHEET ON LEFT.

RECTANGULAR BARNS REQUIRE 34 TO 58 PERCENT MORE MATERIAL

In order to compare the amount and cost of material in round and rectangular barns, the following figures have been carefully worked out by an expert barn builder. Two comparisons, based

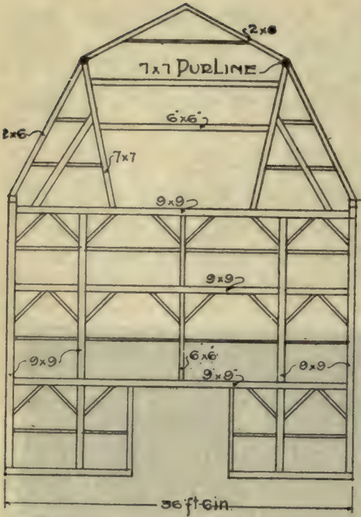

FIG. 6. SHOWING CONSTRUCTION OF MORTISE FRAME BARN, END VIEW.

on wood construction thruout, are made, in which round barns 60 feet and 90 feet in diameter are compared with both plank and mortise frame rectangular barns containing the same number of square feet of floor space, respectively. Since the most practical width of a rectangular dairy barn is 36 feet, its length will depend upon the number of square feet required in the barn.

Figures 6 to 9 are side and end views, showing the detail construction and size of the timbers of the plank frame and mortise frame barns here figured. The detailed figures of the lumber bills for each of these barns were carefully worked out, but are too voluminous for publication here. The total number of feet of each kind of lumber required is given in Tables 1A and 1B. Since the proportion of the different kinds of lumber and shingles varied for the different barns, to draw an exact comparison it was

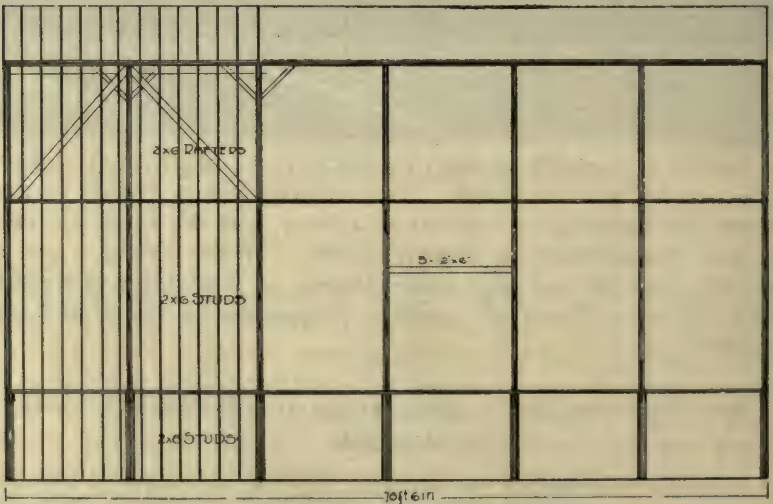

FIG. 7. SHOWING CONSTRUCTION OF PLANK FRAME BARN, SIDE VIEW.

necessary to base it upon the money value, and for this purpose the total cost of lumber has been figured in each case. The lumber values used thruout are the best average prices that could be obtained. As the same prices are used for the material of all the barns, the comparisons of cost are correct, altho these exact prices will not hold for all localities and all times.

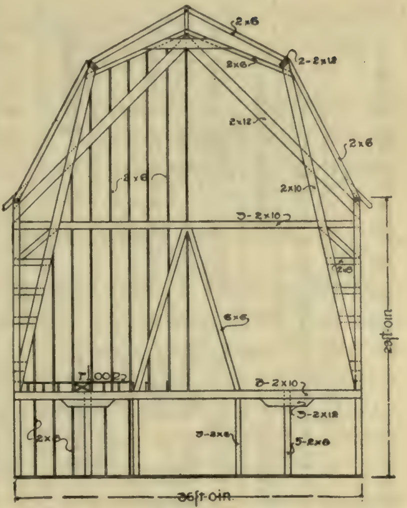

Fig. 8. Showing construction of plank frame barn, end view.

Since a silo cannot be economically built inside of a rectangular barn, the first comparison is made with the barns simply enclosed, altho one of the chief advantages of a round barn is the deep silo which it is possible to build so economically in the center.

Another item of economy in the circular barn is less framing lumber. This form has the strongest possible construction with the least lumber in the frame, and the least bracing, not a single

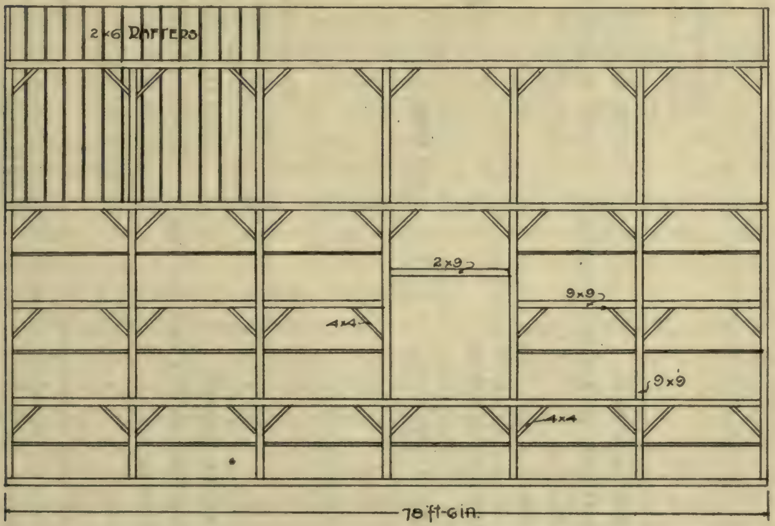

Fig. 9. Showing construction of mortise frame barn, side view.

TABLE 1A.—A COMPARISON OF THE COST OF MATERIAL IN ROUND AND RECTANGULAR BARNS OF THE SAME AREA, *Not Including* FOUNDATION AND SILOS

	Round barn, 60 feet in diameter	Rectangular barn, 36 x 78½ ft.	
		Plank frame	Mortise frame
Framing lumber,	13,976 ft. @ $25=$349.40	19,833 ft. @ $25=$495.83	29,074 ft. @ $25=$726.85
Sheathing, siding and flooring,	12,971 ft. @ $22= 285.36	15,355 ft. @ $22= 337.81	15,355 ft. @ $22= 337.81
Shingles,	44,000 @ $3.75 = 165.00	45,000 @ $3.75 = 168.75	45,000 @ $3.75 = 168.75
Bolts,		20.88	
Total cost of lumber,	**$799.76**	**$1023.27**	**$1233.41**
Content, cubic feet,	**117,669**	**117,138**	**117,138**

TABLE 1B.

	Round barn, 90 feet in diameter	Rectangular barn, 36 x 176¾ ft.	
		Plank frame	Mortise frame
Framing lumber,	30,899 ft. @ $25=$772.48	38,815 ft. @ $25=$970.38	59,481 ft. @ $25=$1487.03
Sheathing, siding and flooring,	22,375 ft. @ 22= 492.25	28,547 ft. @ $22= 628.03	28,547 ft. @ $22= 628.03
Shingles,	97,000 @ $3.75 = 363.75	102,000 @ $3.75= 382.50	102,000 @ $3.75= 382.50
Bolts,		26.76	
Total cost of lumber,	**$1628.48**	**$2007.67**	**$2497.56**
Content, cubic feet,	**322,952**	**270,570**	**270,570**

timber larger than a 2x6 being required above the sill. The arched circular roof requires no supports, and no scaffolding is needed inside during its construction.

The accompanying tables show the comparative amount and value of lumber and cubical content in round barns 60 and 90 feet in diameter, and rectangular barns of equal area and height of posts.

ROUND AND RECTANGULAR BARNS COMPARED

In comparing the 60-foot round barn with a rectangular barn of the same area, the two barns should afford the cows the same amount of space on the platform. Allowing each cow in the 60-foot round barn 3 feet 6 inches in width at the rear of the platform, it will accommodate 40 cows and leave space for two passage ways. But in a rectangular barn, only 3 feet 4 inches of platform space need be allowed for each cow, and the 78½ foot barn, with two 3-foot passage ways across it for convenience in feeding, will accommodate 42 cows. While the rectangular barn has stall room for two more cows, the round barn contains space in the center for a silo 18 feet in diameter.

The floor space and cubical content of the round barn 60 feet in diameter, and the rectangular barn compared with it in these tables, are practically the same, and the barns are therefore directly comparable. This being true, the percentages which were figured from the complete bills of material for these barns show the exact saving in lumber on the 60-foot round barn over the plank and mortise frame rectangular barns 36x78½ feet. The lumber bills of the rectangular barns show an increase in cost of 28 percent for the plank frame and 54 percent for the mortise frame. The round barn, 60 feet in diameter, contains 188½, and the rectangular barn 225 lineal feet of wall. The rectangular barn has, therefore, 22 percent more lineal feet of outside barn wall, requiring a proportional increase in both paint and foundation.

The 176¾-foot rectangular barn would hold 100 cows, allowing each cow 3 feet 4 inches in width and providing for 3 passage ways of 3 feet each across the barn.

The 90-foot round barn would hold 100 cows in two rows headed together, 65 of which would be in the outer circle, and have 3 feet 6 inches each in width at the gutter. This leaves sufficient room for feed alleys and walks, and two passage ways, one three feet and the other seven feet wide for the manure and feed carriers. All of this is outside of a central space for a silo 20 feet in diameter and 71 feet high, with a capacity for 620 tons of silage, and in the mow there would still be an excess, above the capacity of the rectangular barn, of 33,000 cubic feet, which would

TABLE 2A.—A COMPARISON OF THE COST OF MATERIAL IN ROUND AND RECTANGULAR BARNS, *Including* FOUNDATION AND SILOS.

	Round barn, 60 feet in diameter	Rectangular barn, 36 x 78½ f..	
		Plank frame	Mortise frame
Lumber in barn,	$799 76	$1023.27	$1233.41
Material in foundation,	86.89	105.90	105.90
Material in silo,	159.01	295.26	295.26
Total cost of material in barn,	**$1045.66**	**$1424.43**	**$1634.57**
Actual money saved,		**$378.77**	**$588.91**
Proportional cost,	**100**%	**136**%	**156**%

TABLE 2B.

	Round barn, 90 feet in diameter	Rectangular barn, 36 x 176¾ ft.	
		Plank frame	Mortise frame
Lumber in barn,	$1628.48	$2007.67	$2497.56
Material in foundation,	130.35	196.80	196.80
Material in silo,	265.00	513.52	513.52
Total cost of material in barn,	**$2023.83**	**$2717.99**	**$3207.88**
Actual money saved,		**$694.16**	**$1184.05**
Proportional cost,	**100**%	**134**%	**158**%

hold 66 tons of hay, or as much as the entire mow of a barn 32x36 feet with 20-foot posts.

The square feet of floor space in the round barn 90 feet in diameter and rectangular barn 36x176¾ feet are the same, but the cubical content of the former is more than that of the latter. The increase in the lumber bill is 23 percent in the plank frame and 53 percent in the mortise frame barn. The round barn 90 feet in diameter contains 283 and the rectangular barn 426 lineal feet of wall. The rectangular barn has, therefore, 50 percent more lineal feet of outside barn wall, requiring a proportional increase in both paint and foundation.

The smaller surface on the outside wall of the round barn requires less paint and makes a proportional saving in keeping the round barn painted in after years.

ROUND AND RECTANGULAR BARNS, *Including Silos,* COMPARED

Owing to the fact that a silo is a necessity for the most economical production of milk, a barn is not complete for a dairyman's purpose unless it includes a silo with capacity to store sufficient silage for the herd. In the case of the round barn, the silo is most economically built inside, but in the rectangular form would cause a waste of space, and for that reason is best erected outside. Therefore, in comparing a round dairy barn with a rectangular dairy barn, silos should be included.

In figuring the cost of materials in the silos for the round and rectangular barns, the capacity needed in each case was determined in the following manner: Allowing 40 pounds of silage per cow per day for 7 winter months and 25 pounds per cow per day for 3 months during the summer, would require for 40 cows 220 tons; then allowing one-eighth for waste would make the silage requirement 248 tons. As the silo in the round barn 60 feet in diameter is 53 feet deep, it would need to be only 16 feet in diameter to hold 250 tons. This diameter is sufficiently small to allow summer feeding without waste. To erect a silo outside of a barn, with sufficient stability to stand well, the height above ground should not be much more than twice the diameter, and in order to avoid waste for summer feeding, the diameter should not be greater than 16 feet for a herd of 40 cows. In order that a deep enough layer of silage can be fed off each day during the summer to avoid waste, it is evident that to store 250 tons of silage outside the barn, two silos would be required. One of these should be 16 feet in diameter and 36 feet deep, holding 154 tons, and the other 13 feet in diameter and 36 feet deep, holding 102 tons, making a total silo capacity of 256 tons.

As the large barns hold 100 cows, the same allowance of silage per cow for the season would require silo capacity for 620 tons. As the silo in the round barn 90 feet in diameter would be 71 feet deep, it would need to be only 20 feet in diameter to hold 620 tons. To store 620 tons of silage in silos built outside the rectangular barn would require two silos, each 20 feet in diameter and 44 feet deep.* These are the sizes on which the figures for cost of silos of the Gurler type, given in Tables 2A and 2B, were used.

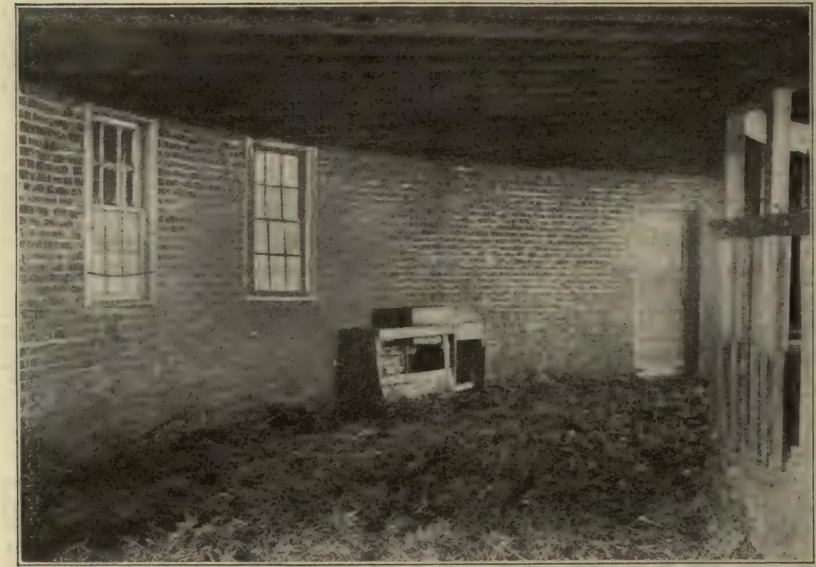

FIG. 10. INTERIOR OF COW STABLE, SHOWING WATER TROUGH WITH FLOAT VALVE, SALT BOX, AND DOOR INTO DAIRY.

The table (page 12) is the final summing up of the cost of all the material for the completed dairy barns, with silos, and shows a saving of from 34 to 58 percent in favor of the round barn and silo, or an actual money saving in this case of from $379 to $1184, depending upon the size and construction of the barns.

Thoughtlessly, men go on building rectangular barns, but what would this reckless disregard of a possible saving of 34 to 58 percent mean in a year's business on the farm? Some illustrations may help us to understand what this money saved in building a round barn really amounts to, and its convenience is also a great saving. If the dairyman discarded the idea of a rectangular barn and built a round barn instead, he could take the money thus saved and buy one of the best pure-bred sires for his herd, and also three to ten pure-bred heifers or fine grade cows. Either of these purchases might double the profit of the herd. Or, this saving, properly applied, would purchase many labor-saving devices which would make life less of a drudgery on many dairy farms. Is not such a saving worth while?

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*Since the deeper the silo the more firmly the silage packs, one silo 71 feet deep will hold as much as two silos of the same diameter and 44 feet deep.

When the comparative cost and merit of two constructions are known, it is a poor financier who will pay extra for the one which is inferior. If a man received bids from contractors for a building, he would be a foolish man who would accept one which is from 34 to 58 percent higher than the lowest bidder, especially when he knew the lowest bidder would put up the most convenient and substantial building.

FIG. 11. COW COMFORT IN A ROUND BARN.

DISADVANTAGES OF THE ROUND DAIRY BARN

The disadvantages of the round dairy barn are, that it cannot be enlarged by building on as readily as can the rectangular form, but as the round barn may be built higher to the eaves than a rectangular barn 36 feet wide, provision can be made for the growth of the herd by building so as to put cows in the second story and still leave sufficient mow room for hay.

The objection is frequently raised that a round barn is difficult to light. This difficulty is entirely overcome in a barn 90 feet or less in diameter, if a sufficient number of properly spaced windows are used. See Figs. 4 and 30. With the same number of windows, the light is more evenly distributed in a round barn and the sun can shine directly into some portion at all hours of the day during the winter.

The objection has been raised that rectangular objects cannot be placed in a circle without a waste of space, but this does not apply to a dairy barn, as the storage of hay and grain depends upon cubical content, alone, and silos should always be circular, no matter where built. Cows, when lying down, are decidedly wedge-shaped, requiring much less space in front than behind. The objection may be raised, with round barns large enough for two rows of cows, that the row headed out does not use the space as economically as in the rectangular form, because a cow needs more width at the rear of the platform than at the manger. Where there are two rows of cows, the inner row is usually headed out, and as only about one-third of the cows are in this row, this loss of space is counterbalanced by the large number of cows in the outer circle using the space more economically than they do in the rectangular barn.

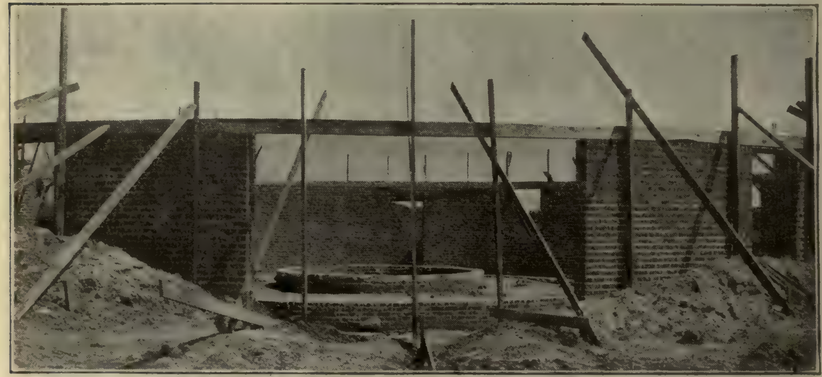

FIG. 12. FIRST STORY WALL, AND FOUNDATION FOR SILO, FEED ALLEY, AND MANGER; SILL IN PLACE, READY FOR JOISTS AND STUDS.

Box stalls cannot be as conveniently arranged, but in a one-row barn, gates hung on the outside and swung around to the manger, form stalls for cows at freshening time, and in a barn with two rows, box stalls can be arranged in the inner circle.

HOW THE ROUND BARN AT THE UNIVERSITY WAS BUILT

The barn is located on the side of a hill, sloping gently to the south and east. With this location, it was an advantage to excavate 5 feet deep on the northwest and run out to the surface of the ground on the southeast.

The footing for the foundation is 18 inches wide. A ten-inch brick wall was carried up nine feet above the stable floor. This wall contains a 2-inch air space to prevent moisture from condensing on the inner wall and making the barn damp. This is an important point, as barns with a solid stone or brick wall are very objectionable on account of dampness. It has been proven by two years' use that this difficulty is entirely obviated by the air space in the wall.

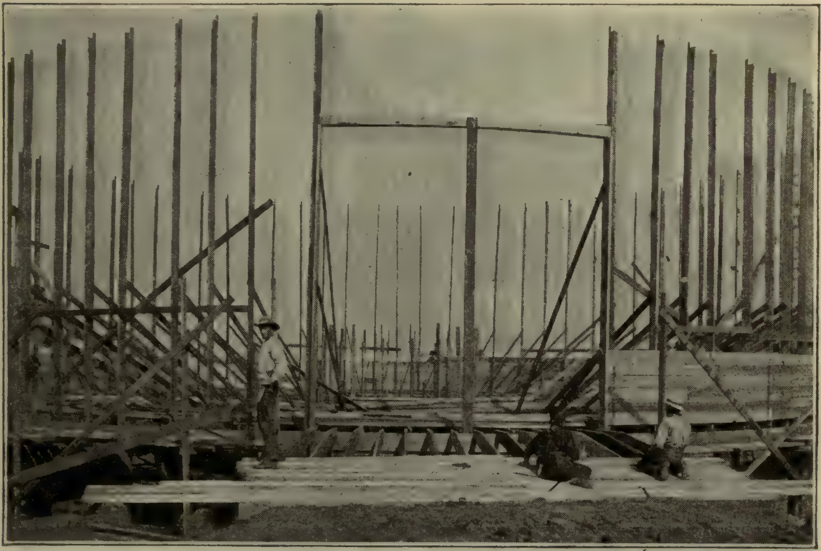

FIG. 13. SHOWING TEMPORARY BRACING TO HOLD STUDS IN PLACE WHILE SHIP LAP CEILING IS NAILED ON.

The foundation for the manger and feed alley is built up 2 feet above the stable floor. The foundation for the silo extends 4 feet below the stable floor and is continued 9 inches above the floor in the feed alley. This silo wall, together with the foundation under the manger, forms the foundation for the center supports of the barn. Fig. 12 shows the foundation completed.

The silo, which is the Gurler type, was then started and carried up with the barn. It was built by placing 2x4 studs around the circle, one foot on centers, and ceiling inside with ½x6-inch lumber. This ½-inch lumber was obtained by re-sawing 1x6 yellow pine fencing. Common lath were then put on horizontally in the regular way inside, without furring out, and plastered with rich cement plaster.

The sill of the barn is 6x6, made up of 1x6s, and built on top of the wall. Building it up in this manner makes a stronger sill than can be obtained in any other way, as it forms a continuous hoop around the barn.

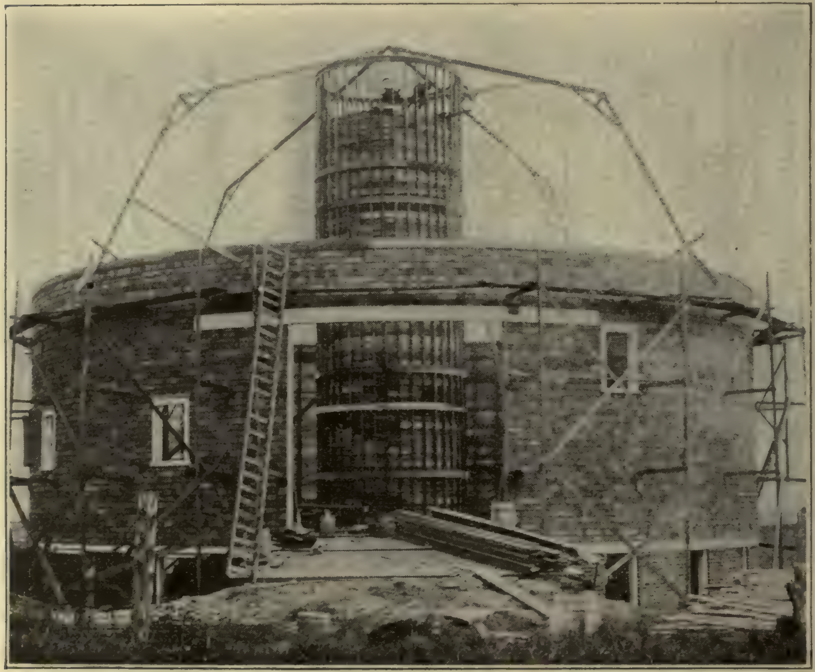

FIG. 14. SHOWING HEIGHT AND CONSTRUCTION OF SILO, SIDING COMPLETED, AND FOUR MAIN RAFTERS IN PLACE.

The joists are 2x12s notched 6 inches to fit the sill, so that the outer ends rest on both the sill and the brick wall. The outer span of joists is 14 feet and the inner ends of these joists rest on a similar sill built of 1x6s on top of the 4x4 supports at the stanchions. The inner span of joists, between the stanchions and the silo, is 8 feet, the outer end resting on the sill over the stanchions, and the inner end on a 1½x6-inch band, made up of three ½x6-inch pieces, running around the outside of the silo. These joists are placed 2½ feet apart at the outside of the barn, and half as many joists are used in the inner span, making the joists at the silo one foot apart. The number of joists under the driveways are doubled, being only 1 foot and 3 inches apart at the outside of the barn.

The studs, which are 2x6s, 20 feet long, were then placed on the sill, about 2 feet 6 inches apart, being as evenly spaced between the windows as possible, and temporarily braced, as shown in Fig. 13, until the 8-inch ship lap ceiling could be nailed on the outside. This was carried up 5 feet to the second scaffold, and then covered to this height with shingles laid 5 inches to the weather. The scaffolding was then moved up and this process repeated until the siding was completed. The plate, made up of five 1x4s, was then built in the notch in the top of the studs shown in Fig. 13.

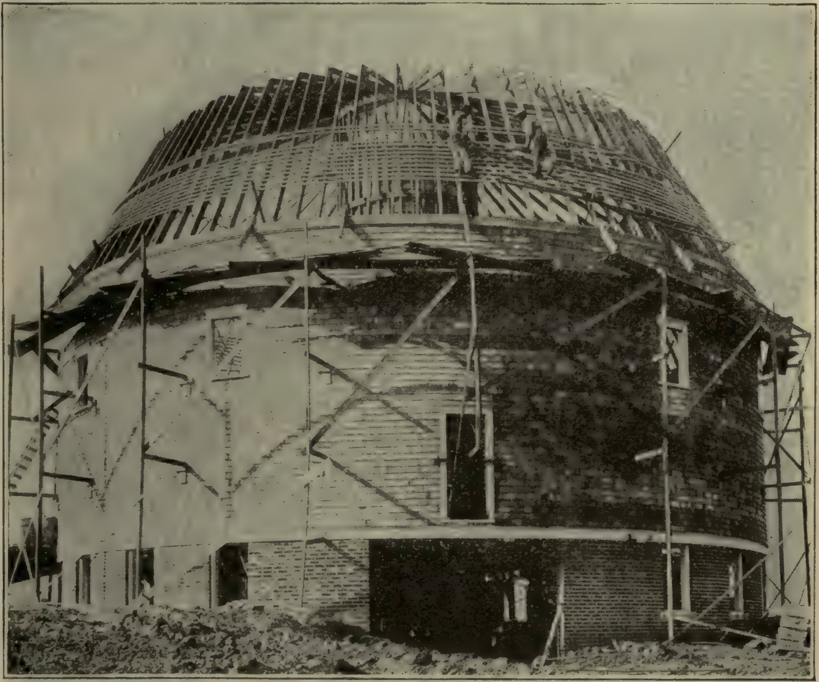

FIG. 15. SHOWING ALL RAFTERS IN PLACE AND METHOD OF SHEATHING ROOF.

The silo was completed, as before described. The rafters, which were framed on the ground, were then erected, as shown in Fig. 14, the first eight going to the center of the roof, and the

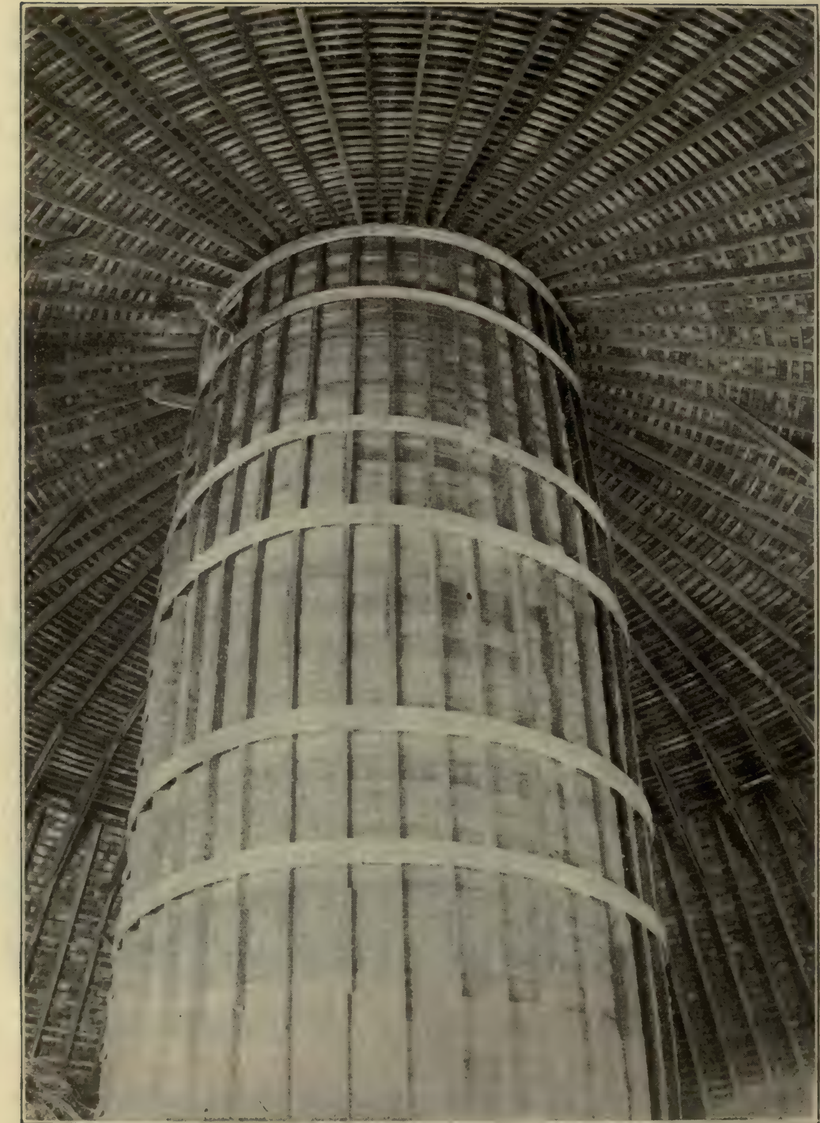

FIG. 16. SHOWING HEIGHT OF SILO, CAPACITY OF BARN, AND CONSTRUCTION OF ROOF.

remaining ones were cut to rest on the plate of the silo. There are 64 framed rafters, and these are the only ones in the upper section of the roof. At the break in the roof, a header is cut in between the framed rafters, and in the lower section a rafter is placed between these, thus making twice as many rafters in the lower section of the roof as in the upper section. After the rafters were all in place and temporarily braced, the 1x2-inch sheathing was put on, as shown in Fig 15, and the shingles, which were the best 5/2 red cedar, were laid 5 inches to the weather on the lower section of the roof, and 4 inches to the weather on the upper section, as this had less pitch. No chalk line was necessary, as the shingles were laid by the sheathing.

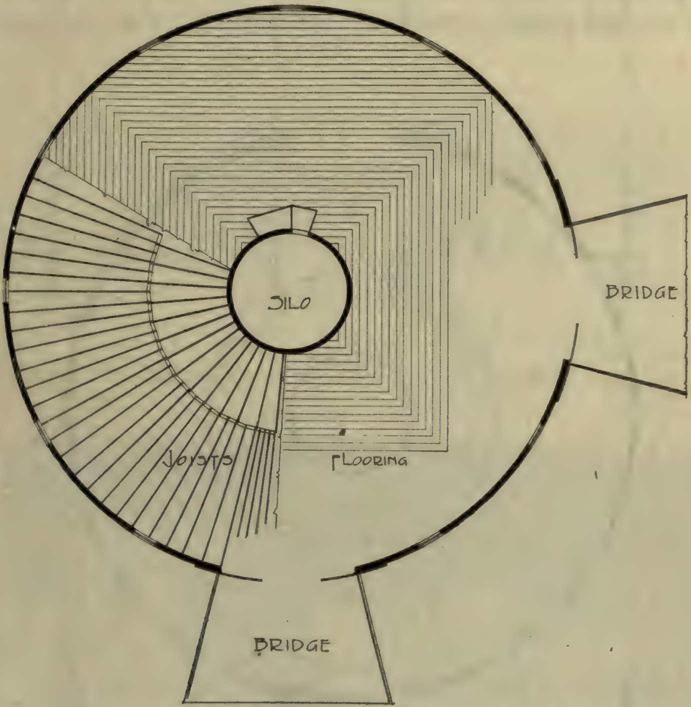

FIG. 17. SHOWING ARRANGEMENT OF JOISTS AND HOW THE FLOOR IS LAID.

The floor was made of 1x8 ship lap, laid in four directions, as shown in Fig. 17. In the driveway an extra layer of ship lap was used, making this portion of the floor 2 inches thick.

The doorways in the second story are 14 feet wide, and in the lower story 12 feet. These openings are closed by two sliding doors, each door being made of two sections, hinged together so as to follow the circular wall of the barn in opening.

The cow stable is on the ground floor, and well lighted by 16 windows having twelve 9x12 lights each. There are also six windows in the doors. The windows are placed just below the ceiling and admit an abundance of sunshine at all times of the day, which is one of the essentials of a good dairy barn.

The floor, back of the manger, is of clay, except at the door, where a small portion is covered with cement. The cows run loose

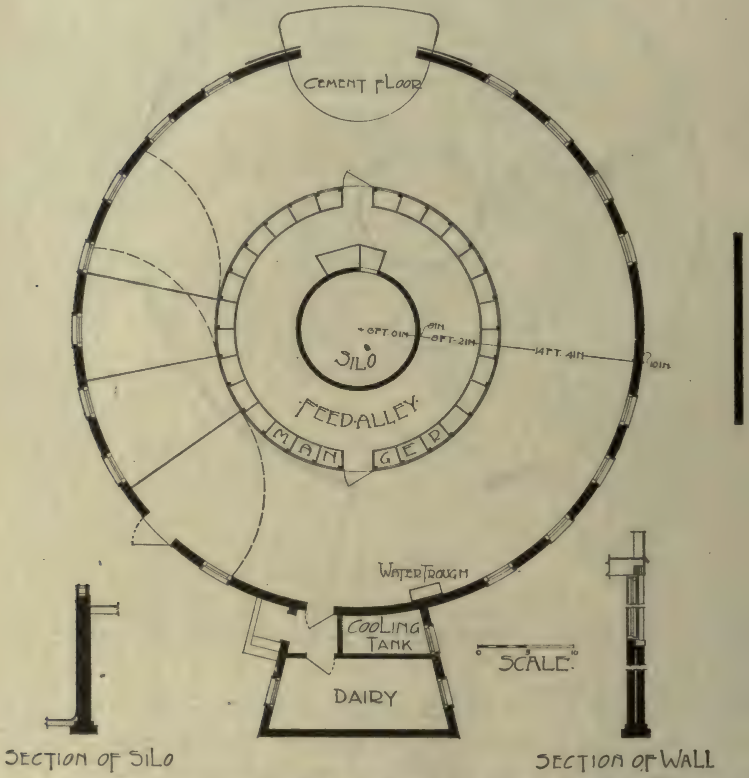

FIG. 18. SHOWING PRESENT ARRANGEMENT OF COW STABLE. THERE ARE STANCHIONS AND MANGERS FOR 28 COWS, AND 2200 SQ. FT. OF FLOOR SPACE IN WHICH THE COWS CAN RUN LOOSE. THE GATES ARE SWUNG INTO THE PRESENT POSITION WHEN BOX STALLS ARE NEEDED.

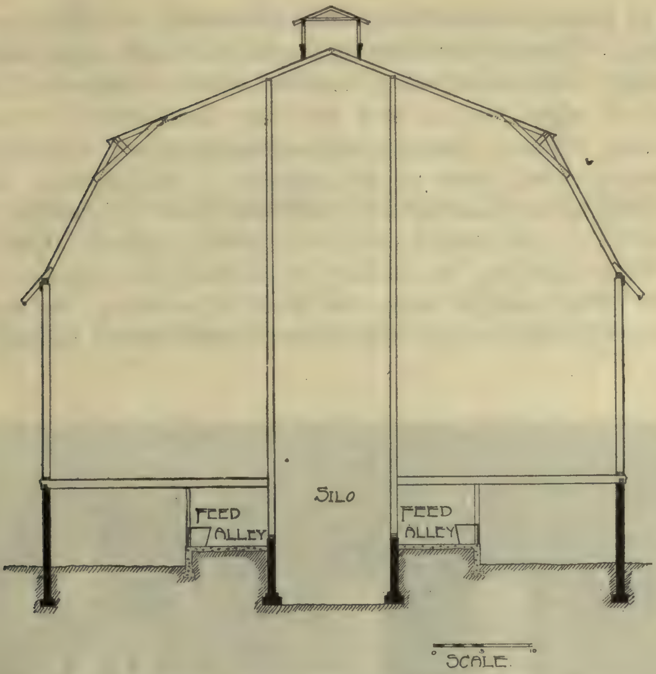

FIG. 19. SHOWING CROSS SECTION OF 60-FOOT ROUND BARN.

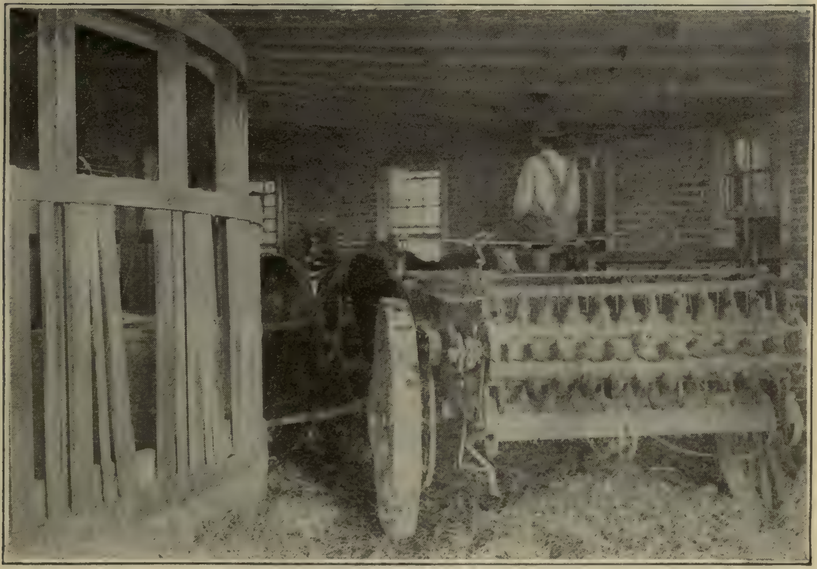

FIG. 20. CLEANING OUT COW STABLE WITH THREE-HORSE MANURE SPREADER.

except at feeding and milking time, when they are placed in rigid stanchions. It must be distinctly understood that rigid stanchions are strongly condemned as a cow tie, where cows are to remain in them all night, but as they are here used merely to hold the cow during milking, they are both economical and convenient.

Running cows loose in this manner is an excellent method, where bedding is abundant and sufficient space is available, as the cows are more comfortable, and all fertility is saved. There is no waste from leaching, as when the manure lies exposed to the weather. This method saves the labor of cleaning the stable, as the manure is loaded into the spreader and hauled directly upon the land whenever convenient, and the land is in the best condition to receive it.*

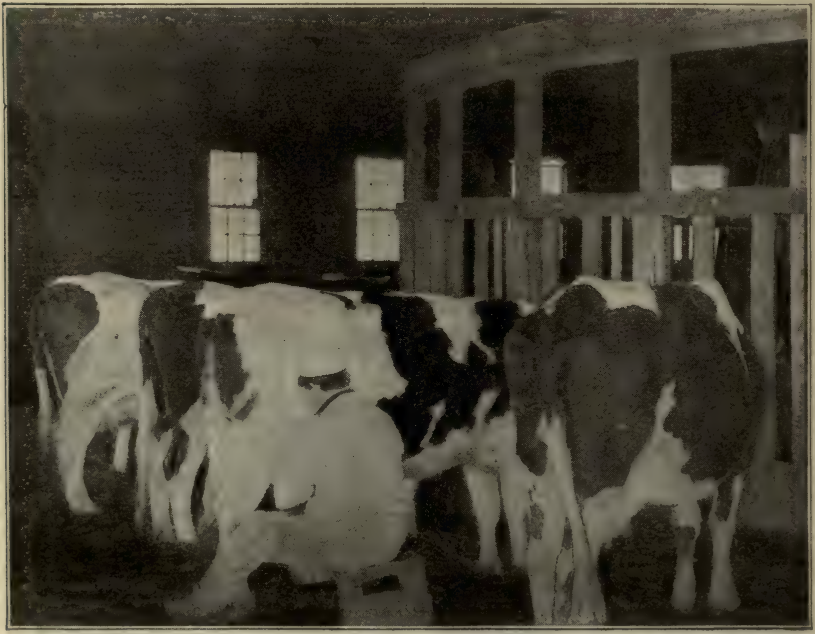

FIG. 21. COWS IN STANCHION AT MILKING TIME.

Three gates are hung on posts at the outside wall, and when box stalls are needed, these are swung around to the manger, as shown in Fig. 18. The south door in the cow stable can be closed by slatted gates, thus affording an abundance of fresh air and sunshine on nice days, without letting the cows out of the barn.

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*For a more detailed discussion of the advantages of keeping cows in this manner, see Illinois Agricultural Experiment Station Circular No. 93.

SYSTEM OF VENTILATION

The system of ventilation is the "King." To economize space and lumber, the hay chute is used for a ventilator. This chute, which extends to the cupola, is 2¼x3½ feet, having a cross section area of 8 sq. ft., which, with a good draft, is sufficient for 40 cows. In order that this combination of ventilator and hay chute prove practical, doors thru which the hay could be thrust were placed at intervals in the side of the chute. These doors are hinged at the top, opening in, and close immediately after the hay drops, thus maintaining a closed ventilator chute. The air is drawn in at the bottom, the amount being regulated by means of a sliding door in the side. As this chute is 50 feet high, it creates a strong suction.

FIG. 21. CONTINUED.

THE MILK ROOM

To economize space, the milk room, 12x16 feet, is located under the north driveway. The brick walls under the drive form the sides of this room, and the floor of the drive, which is made of 2x6s grooved on both edges, forms the roof. The grooves in the flooring were filled with white lead, and a wooden strip, fitted to fill the grooves of both planks, was driven in, forming a water-tight floor. This floor was covered with hot tar and sand ½ inch thick. The milk room is plastered on the inside, the plaster being applied directly to the brick walls, excepting in the case of the ceiling, which is lathed. The floor and cooling tank are of cement. The passage from the barn to the milk room is thru a small hallway, which is open to the outside, thus preventing the stable air getting into the milk room.

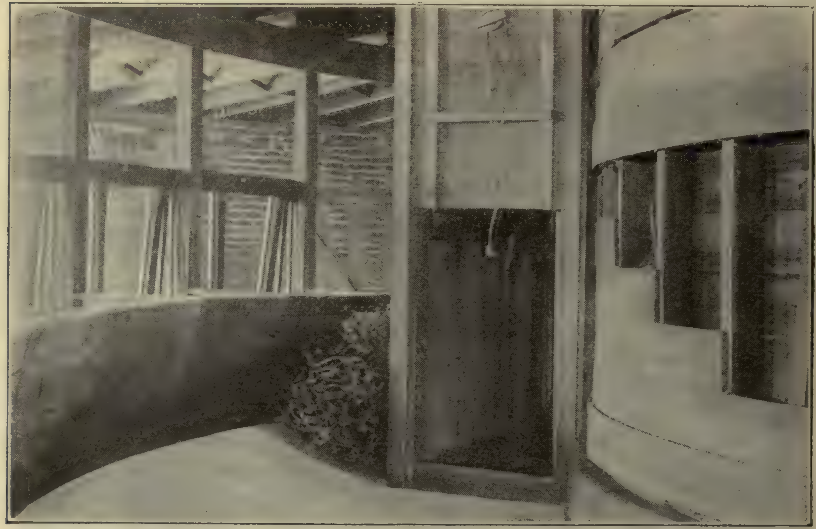

FIG. 22. FEED ALLEY, SHOWING COMBINED HAY CHUTE AND VENTILATOR. A DOOR ON THE SIDE WHICH IS HINGED AT THE BOTTOM, 3 FEET FROM THE FLOOR, IS LET IN TOWARD THE SILO, SLIDING THE HAY ONTO THE FLOOR. IN HOT WEATHER THIS OPENING TAKES THE HEAT OUT OF THE BARN; DURING THE WINTER THIS DOOR IS KEPT CLOSED AND THE VENTILATION IS REGULATED BY RAISING THE SLIDE, AS SHOWN IN THE CUT.

BARN SATISFACTORY

This round dairy barn above described has been in use for over two years at the University of Illinois, and has given entire satisfaction.

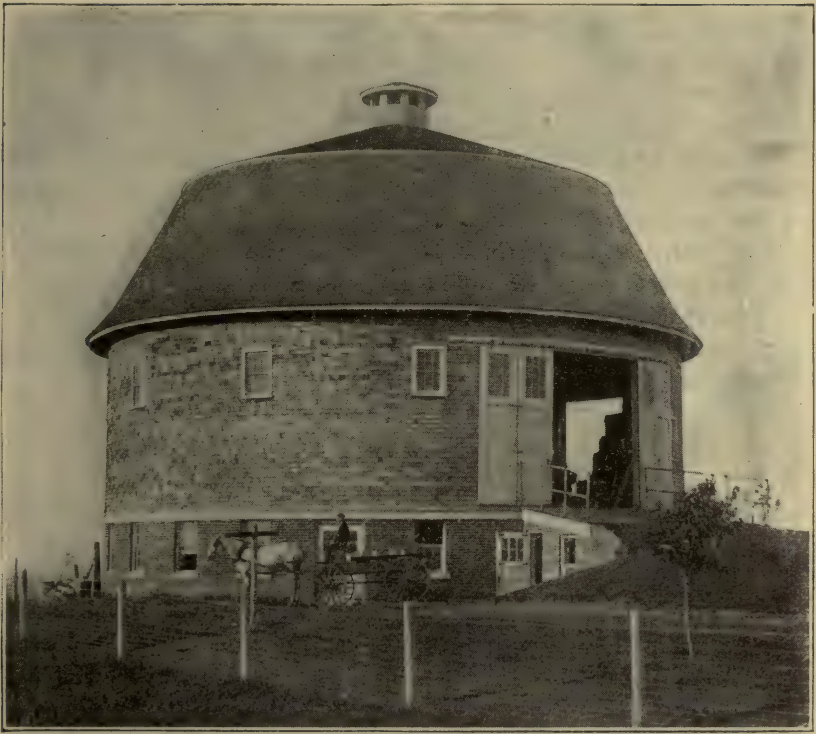

FIG. 23. NORTHEAST VIEW, SHOWING DAIRY UNDER DRIVEWAY. THE BARN IS ON THE SAME SCALE AS THE DRAWING ON PAGE 28.

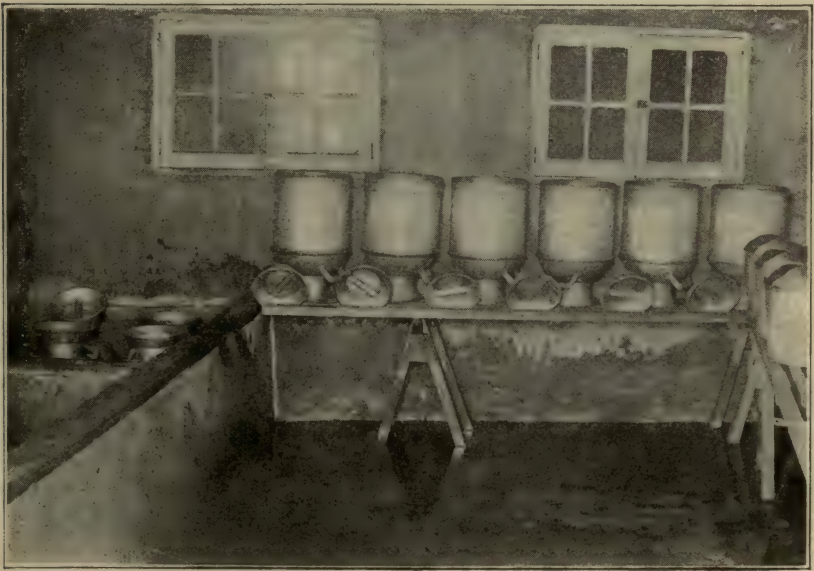

FIG. 24. INTERIOR OF DAIRY; COOLING TANK ON LEFT.

Re-arrangement of Barn to Accommodate 40 Cows

If it is desired to keep cows in stalls in a round barn of this size, the circular manger can be enlarged to 38 feet in diameter, which gives room for forty cows, as shown in Fig. 25, and the silo, to hold sufficient silage to feed the year round, enlarged to 18 feet in diameter. The present mow room is sufficient to store enough hay and bedding for this number of cows.

The barn on the Twenty-acre Demonstration Dairy Farm was built this large, as it was thought it might be desired at some future time to increase the size of the farm and herd, and the barn could easily be changed to accommodate a larger herd by simply enlarging the silo, without rebuilding the barn.

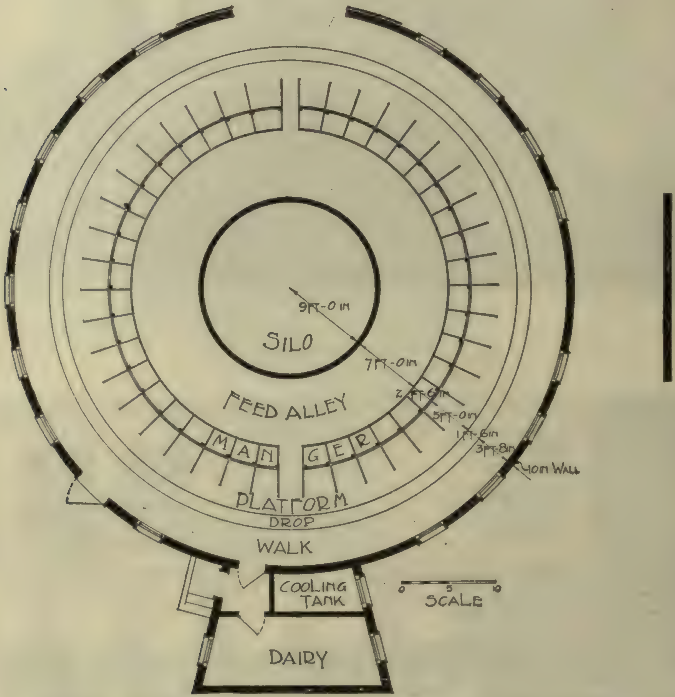

Fig. 25. Showing how this 60-foot barn may be arranged to accommodate 40 cows in stalls. To supply this sized herd and the necessary young stock with silage for eight months would require a 370-ton silo, or one 18 feet in diameter and 56 feet deep; With a seven-foot feed alley and a 2½-foot manger, the circle at the stanchions would be 38 feet in diameter, or 119⅓ feet in circumference; Allowing 4¼ feet for two passage ways, the stalls would be 2 feet 10½ inches wide at the stanchion, and 3 feet 6 inches at the drop.

ITEMIZED COST OF THIS ROUND BARN

Excavating, foundation, and first story brick wall	$904.00

Lumber:

149 pieces, 1x 4x16 Y. P.
31 “ 1x 4x14 Cypress
16 “ 1x 4x12
165 “ 1x 6x16 Y. P.
17 “ 1x 6x14 “
226 “ 2x 4x12 “
20 “ 2x 4x16 “
6 “ 2x 4x14 “
15 “ 4x 4x14 “
120 “ 2x12x16 “
23 “ 2x12x14 “
100 “ 2x 6x20 “
144 “ 2x 6x16 “
67 “ 2x 6x18 “
4 “ 2x 6x26 “
60 pieces, 2x 6x12 Y. P.
30 “ 2x 6x22 “
4 “ 2x 6x24 “
6 “ 2x 8x10 “
9 “ 2x 8x16 “
4 “ 2x10x14 “
11 “ 2x10x12 “
1 “ 2x10x22 “
1 “ 1x10x12 “
1 “ 1x10x14 Cypress
2 “ 1x12x14 “
22 “ 1⅛x8x10 Cyp. S2S
2 “ 1x1⅛x12x14
2 “ 1x1⅛x12x16
6000 feet of 8-inch ship lap
3150 feet of 10-inch ship lap
71 M 5/2 red cedar shingles
165 Lineal feet of 2-inch Cr. molding
240 Lineal feet of Cr. molding
270 feet of 4-inch Y. P. S1S
4000 feet of 6-inch rough pine
62 feet of ⅜-inch Y. P. Ceiling
850 feet of 6-inch No. 1 flooring
230 feet of 6-inch fence flooring
56 lineal feet of ½x3-inch battening
32 lineal feet of lattice
444 lineal feet of 4-inch cypress
3 10-foot cedar posts

Total cost of lumber	$1,313.63

Mill work:

Window sash and doors	$270.00
Window and door frames	71.00
Sawing lumber for silo, roof, bridge and stanchions	29.78
Cost of hardware	96.57

Carpenter work:

Head carpenter	518 hrs.	@ 40c=	$207.20
Carpenters	1057 hrs.	@ 35c=	369.95
Common labor	429 hrs.	@ 20c=	85.80

Total cost for carpenter work	662.95
Tiling around barn and silo, sewer from dairy room, retaining wall, cement floor in alley, dairy, doorway of barn, and steps and tanks	128.54
Plastering dairy room and inside of silo	104.60
Painting	89.54
Total cost of barn	$3670.61

The cost of this barn, if built on the ordinary dairy farm, could be materially reduced without shortening the life of the barn. Owing to the conditions under which this barn was built, it was necessary to pay for hauling all material to the farm, two and one-half miles from town. All of the labor had to be hired, and as it was necessary for the men to board themselves the wages paid were proportionately higher. The farmer usually does the excavating and hauls the brick, sand, and lumber with his own teams, tends the mason, and does quite an amount of the rough work with his own help, besides boarding the men, all of which would greatly reduce the cost. The construction could also be cheapened by using drop siding to cover the outside, instead of shingles, which in this case were used over ship lap on the side walls to improve the appearance. This barn could be still further cheapened by putting hoops, five feet apart, around the studs, and covering with common 1x12 boards, put on vertically, as is done in some cases. A saving could also be made on the mill work and large doors by

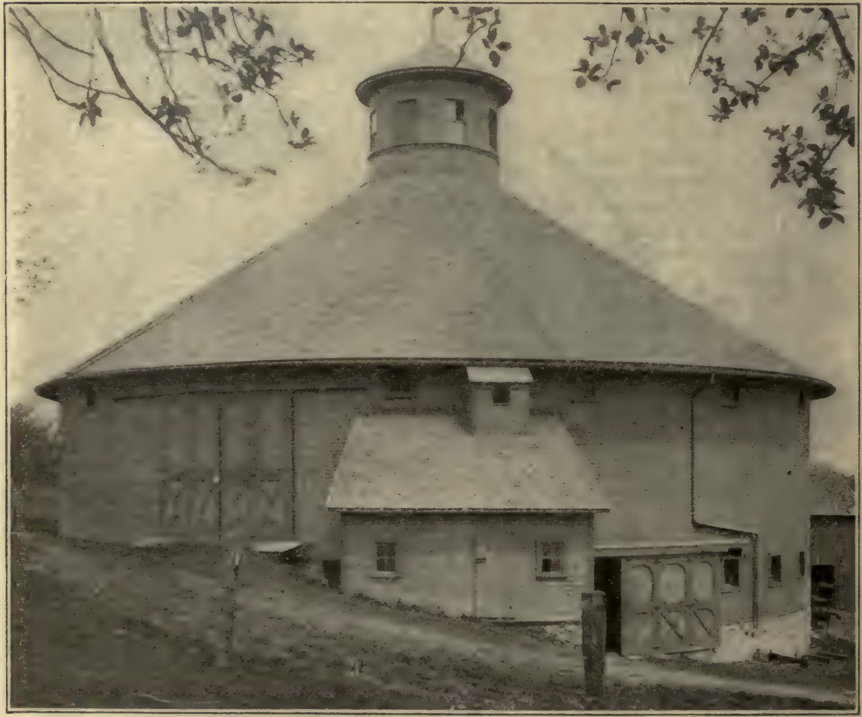

FIG. 26. BARN NO. 2, 80 FEET IN DIAMETER; ENGINE ROOM IN FOREGROUND.

having the carpenters make these plainer and leave the windows out of them.

Anyone wishing to build a round barn can get local bids on the lumber bill, and determine approximately the cost in his locality. This will vary with both the location and the year.

OTHER ROUND DAIRY BARNS

BARN NO. 2

Built 1897.

Diameter, 80 feet.

Capacity, 75 cows in 2 rows, tails together, 51 head in outer circle, 24 head in inner circle.

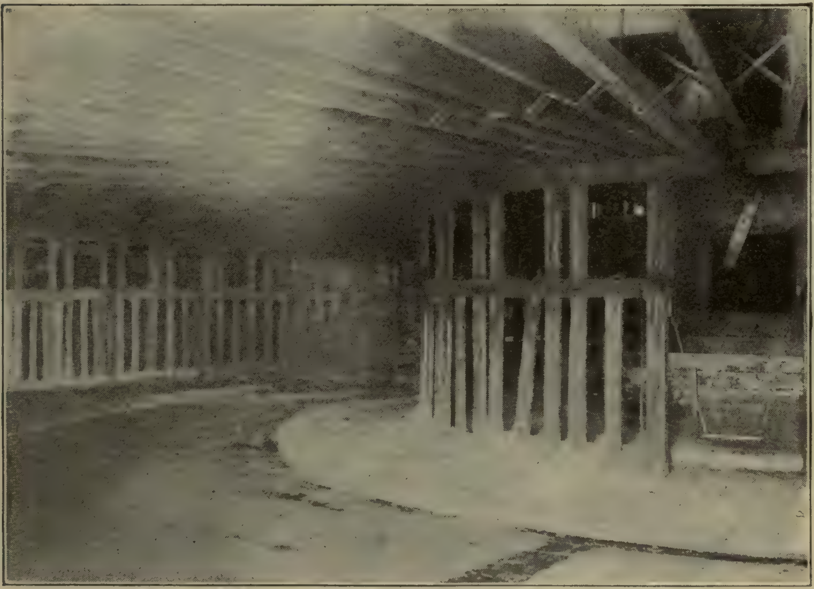

FIG. 27. INTERIOR OF BARN NO. 2, SHOWING TWO ROWS OF STANCHIONS AND DRIVE BEHIND COWS WHICH IS USED IN CLEANING BARN; SILO ON RIGHT.

Cost, $1800.

Studs, 2x6s, placed 2½ feet on center.

Supports, two 2x6s in each stanchion.

Joists, main span 3x12s, 20 feet long, placed 14 inches on center. Short spans over feed alleys, 2x10s.

Plate, 1x10-inch boards sprung around near top of studs.

Roof supports, 6x6s placed 12 feet apart. Purline plate rests on these posts and consists of 1x8s sprung to the circle.

Siding, 8-inch, put on horizontally, first story ceiled inside.

To clean out, a wagon is driven around between the two rows of cows.

The chief objection to this barn is insufficient light in the cow stable.

This barn and No. 3 are approximately the same in construction, and are more substantially built than barns No. 4 and 5.

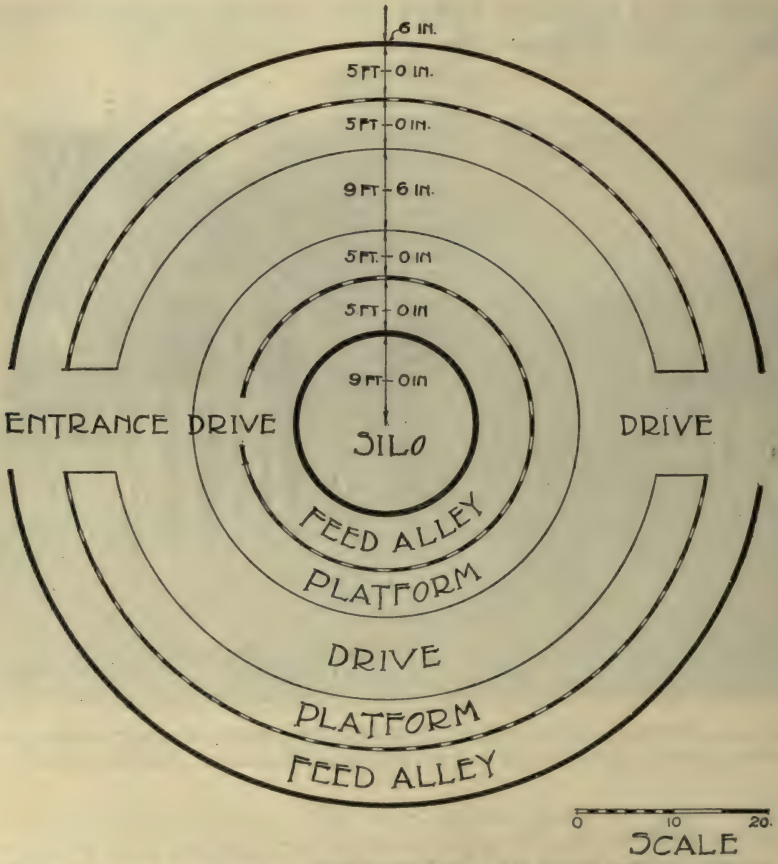

FIG. 28. ARRANGEMENT OF COW STABLE IN BARN NO. 2; TWO ROWS OF COWS TAILED TOGETHER. THE BARN IS CLEANED BY DRIVING AROUND BEHIND THE COWS.

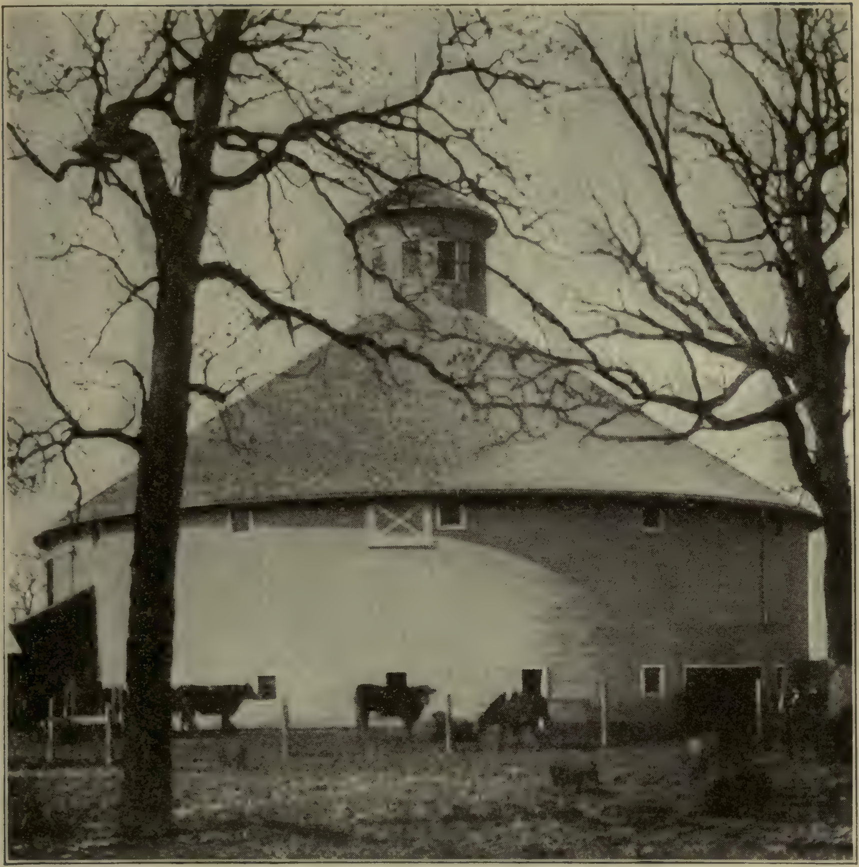

FIG. 29. BARN NO. 3, 80 FEET IN DIAMETER.

BARN NO. 4

Built in 1900.

Diameter, 90 feet.

Capacity, 105 cows, two rows heading together.

Cost, $3000.

Foundation, width at base and top, 18 inches; depth in ground, 20 inches, (not sufficient).

Sills, 2x8s, sawed in short lengths, and placed flatwise.

Studding, 20-foot 2x8s, placed 3 feet on center and toenailed to sill.

Supports, first story 4x4s placed between stanchions in each row, making two rows of supports between the outside wall and the silo; 4x4s cut to a circle placed on top of these supports. The outside span, over cows, is 13 feet 6 inches; middle span, over feed alley, 6 feet 8 inches, and inside span, over cows, 13 feet.

Joists, 2x8s placed 3 feet apart at studs on outside wall. There are as many joists in center of barn as at the outside.

Supports, second-story, consist of one row of posts running around at a point immediately under the break in the roof. These are 16 feet apart and are made of three 2x8s kept 2 inches apart by horizontal braces which run from studding near the eave thru these posts to studding in silo. See Fig. 31.

Plate, rafter is set on top of each stud, and no plate is used.

Rafters, 2x6s resting on studs at outside and on circular plate at break in roof.

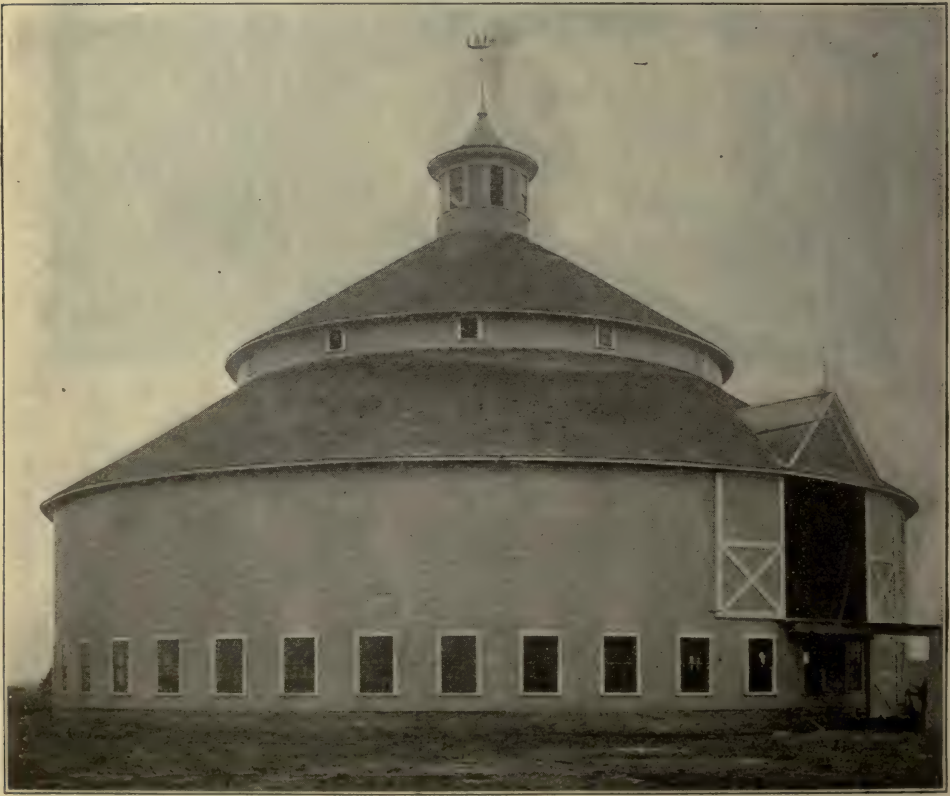

FIG. 30. BARN NO. 4, 90 FEET IN DIAMETER; ONE OF THE FEW DAIRY BARNS WITH SUFFICIENT LIGHT; SAME SCALE AS DRAWING ON PAGE 37.

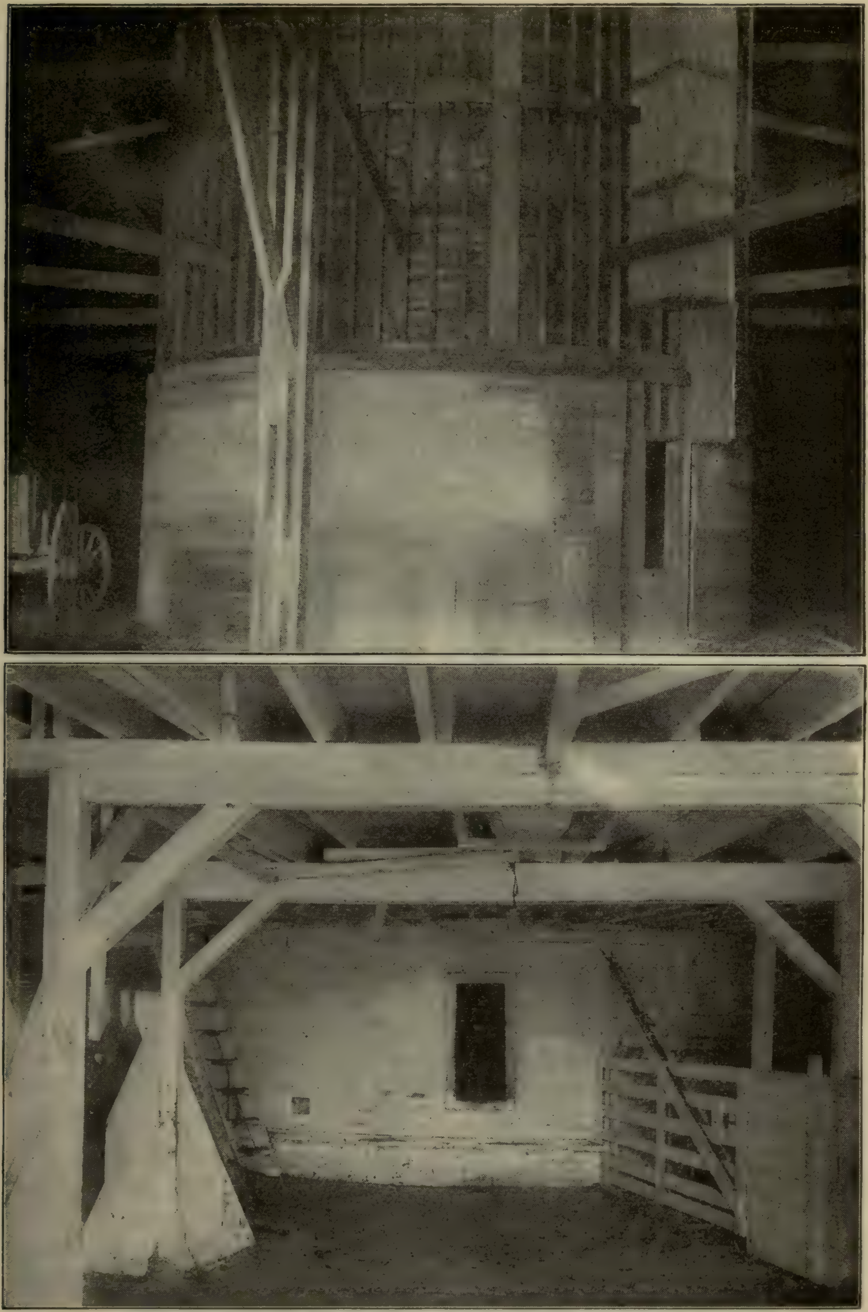

FIG. 31. SILO IN CENTER OF BARN NO. 4; UPPER PORTION IN HAY LOFT, LOWER PORTION IN COW STABLE.

Siding, 8-inch drop siding, put on horizontally, nailed with 10d nails. Ends holding well.

Windows, 12 light, 10x12 glass; one window every six feet. This gives an abundance of light in the center of the barn.

Doors, built on circle; (not satisfactory).

Silo, round; diameter, 24 feet over all; height, 53 feet, exclusive of 12-foot space for water tank on top; capacity, 500 tons.

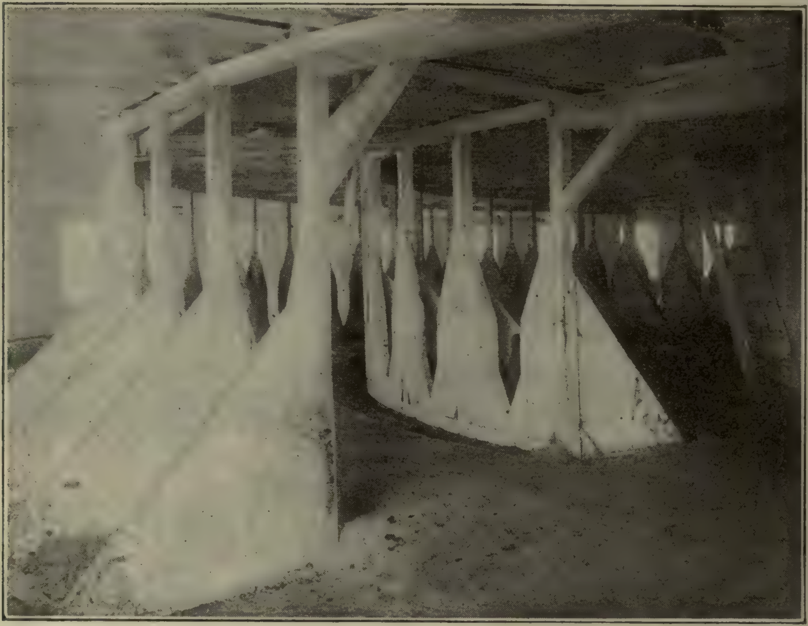

FIG. 32. INTERIOR OF BARN NO. 4, SHOWING STALLS AND FEED ALLEY.

Studs of silo, 2x4s placed 12 inches on center. Ceiled inside of studs with two thicknesses of half-inch lumber with paper between.

Remarks: Considering its size, the construction of this barn is apparently too light to be substantial, as the joists and studs are too small and too far apart, yet it has stood for nine years with no more evidence of wear than is common with any barn.

Were the owner to build again he would place the studs only 2½ feet apart and use 2x12 joists, 2½ feet apart at the outside wall. He would also use cement plaster on inside of silo.

The owner says it would have cost him as much to have built a rectangular barn without the 500-ton silo, and containing 1300 sq. ft. less floor space. In other words, he gained a 500-ton silo and 1300 sq. ft. of floor space, besides an immense amount of mow room, by building a circular barn.

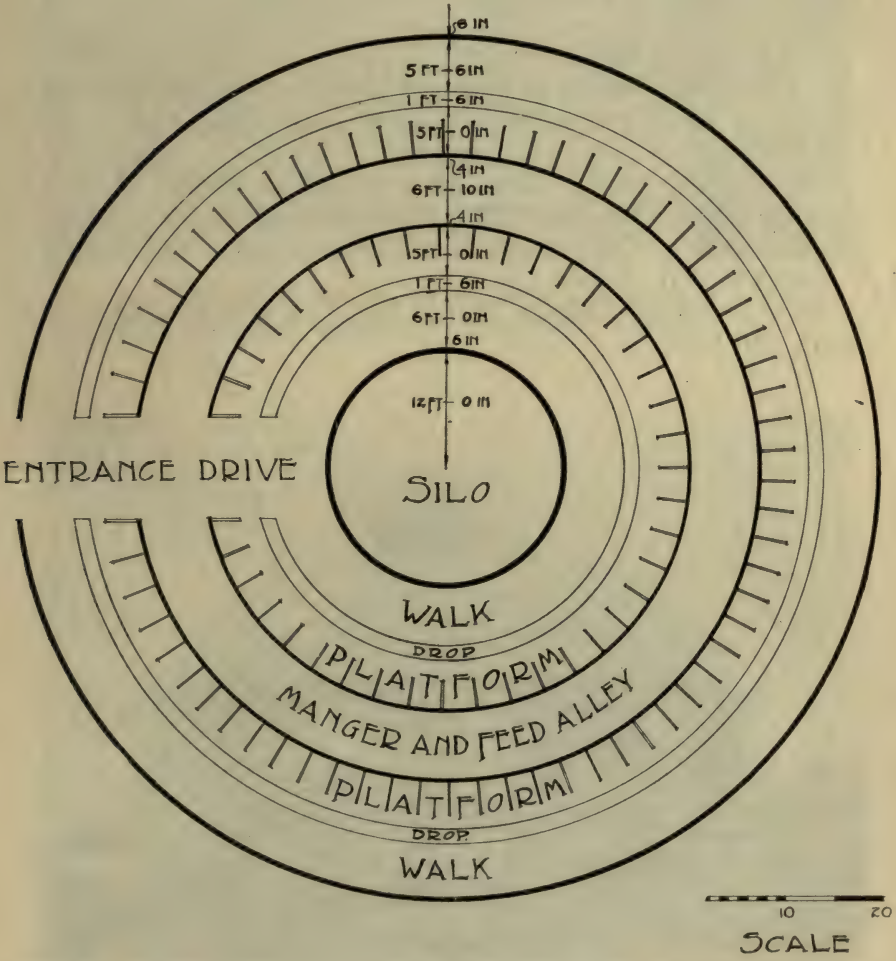

FIG. 33. ARRANGEMENT OF COW STABLE IN BARN NO. 4, 90 FEET IN DIAMETER; TWO ROWS OF COWS HEADED TOGETHER.

BARN NO. 5

Built in 1906.

Diameter, 100 feet.

Capacity, 115 cows.

Cost, $3400.

Studding, 16-foot 2x6s, placed 3 feet on centers.

Supports, 3 rows 4x4s.

Joists, 2x10s, placed 3 feet on centers. Hemlock and yellow pine.

Floor, laid in eight directions.

Rafters, 2x6s spiked to studs. A band of two 1x6s is placed around the studs just below the rafters, and helps support the rafters.

Supports for roof. There are three purline plates. Two of these are supported by posts, the other by braces running out from the silo. The roof is straight from eaves to peak. The bracing is similar to that of barn No. 4.

Silo, 18 feet in diameter, 56 feet deep, 2 feet in ground. Capacity, 350 tons.

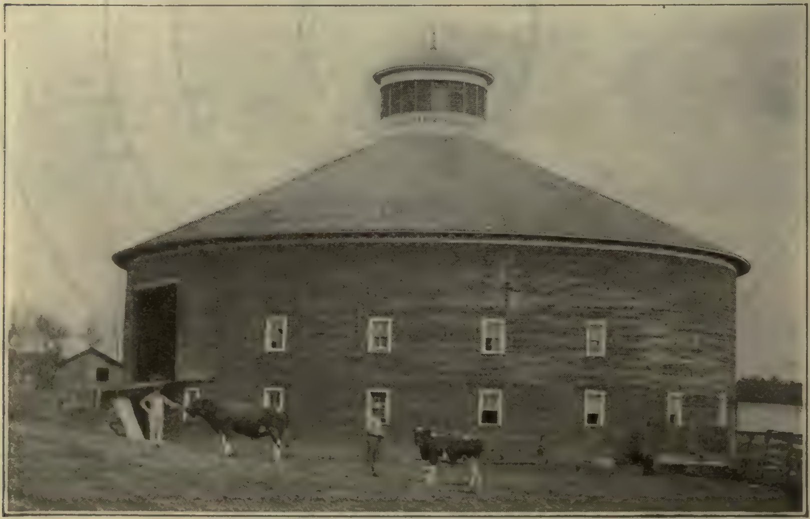

FIG. 34. BARN 92 FEET IN DIAMETER; TWO ROWS OF COWS HEADED TOGETHER; SILO IN CENTER.

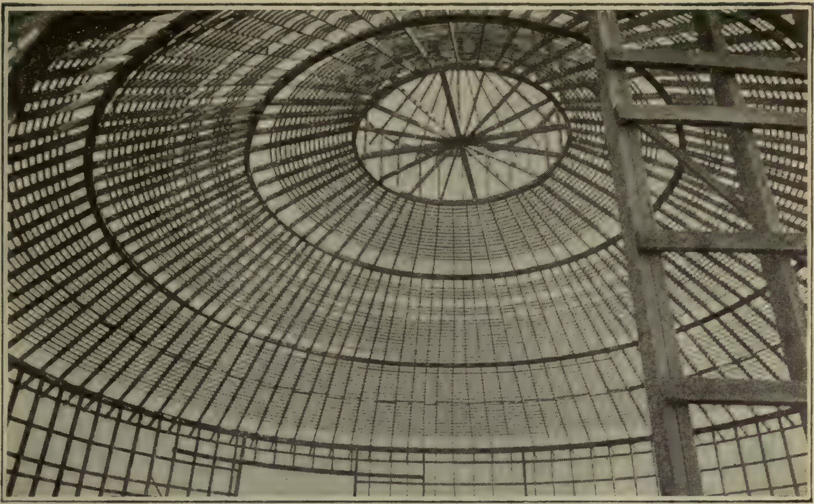

FIG. 35. VIEW OF 70-FOOT SELF SUPPORTING ROOF ON BARN SHOWN IN FIG. 36; NOTE HOOPS ON STUDS IN RIGHT FOREGROUND.

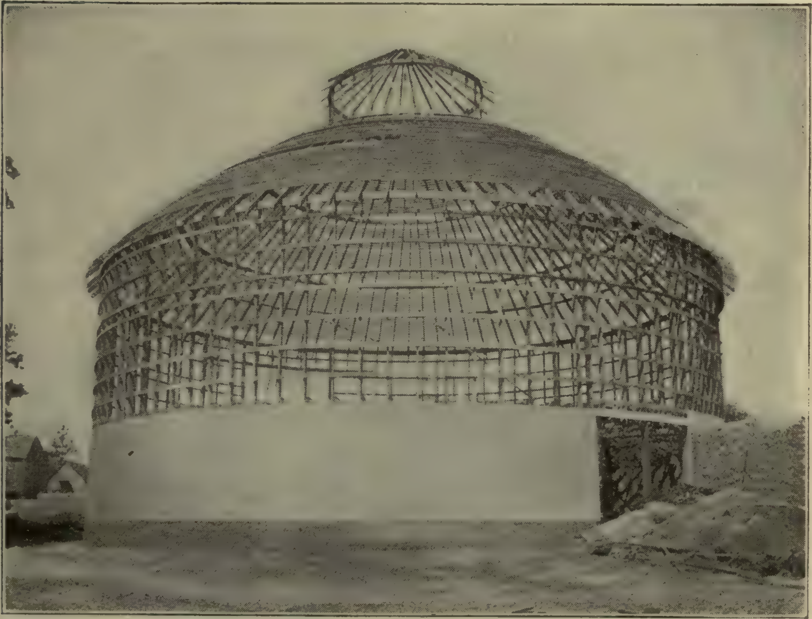

FIG. 36. BARN 70 FEET IN DIAMETER; FRAME HOOPED FOR PERPENDICULAR SIDING; LOWER SECTION SIDED.

THE SMALL DAIRYMAN'S BARN

The round barns previously described do not meet the needs of the man with only a few cows. He usually wants a general-purpose barn. The circular form can be made satisfactory for this

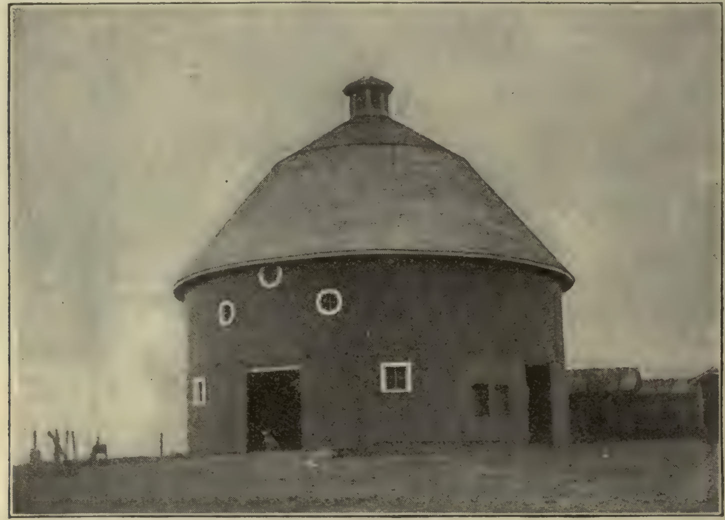

FIG. 37. BARN 40 FEET IN DIAMETER.

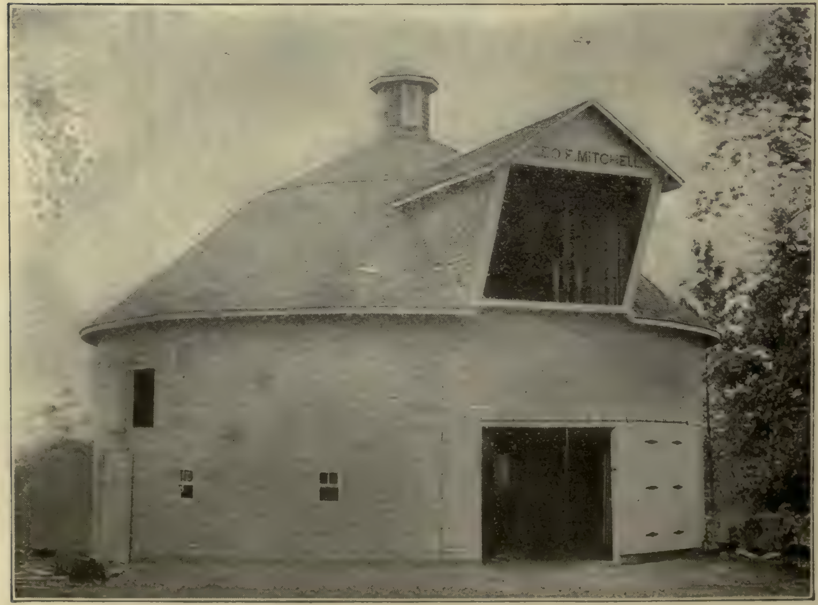

FIG. 38. BARN 48 FEET IN DIAMETER, 16-FOOT POSTS; NOTE METHOD OF TAKING HAY INTO SMALL ROUND BARN.

purpose if proper attention is given to the plan. It is necessary that the cow stable be distinctly separated from all other stock by a tight wall. Round barns with this arrangement are giving satisfaction in Illinois at the present time.

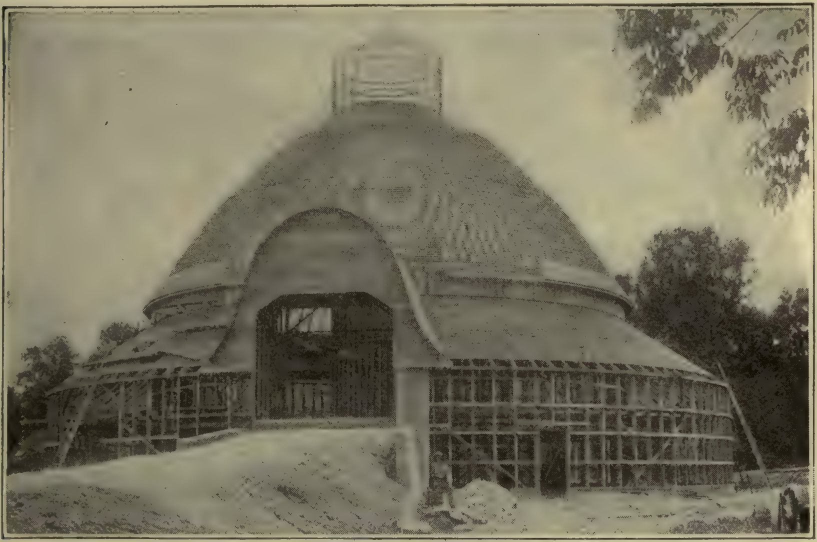

FIG. 39. SHOWING CONSTRUCTION OF BARN IN FIG. 40. HOOPS IN PLACE READY FOR PERPENDICULAR SIDING; ROOF SHEATHED FOR SHINGLES.

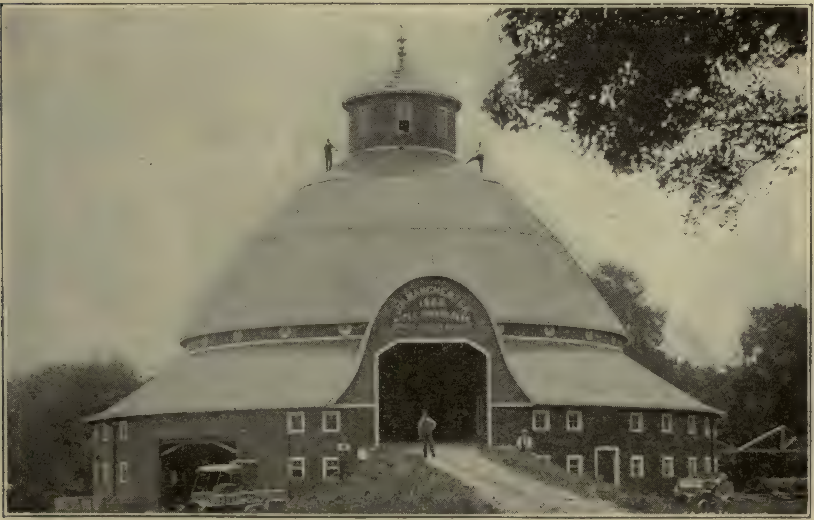

FIG. 40. BARN 102 FEET IN DIAMETER AND 85 FEET HIGH.

DISADVANTAGES OF THE POLYGONAL BARN

A polygonal barn has the disadvantages of both the rectangular and the round barn, and is less stable than either. It must necessarily have a heavy frame, which is expensive, and as the siding cannot run around the corners, it is very difficult to tie the different sides together sufficiently to prevent the barn being racked by the wind.

BARN No. 6

16-sided.
Built, 1888.

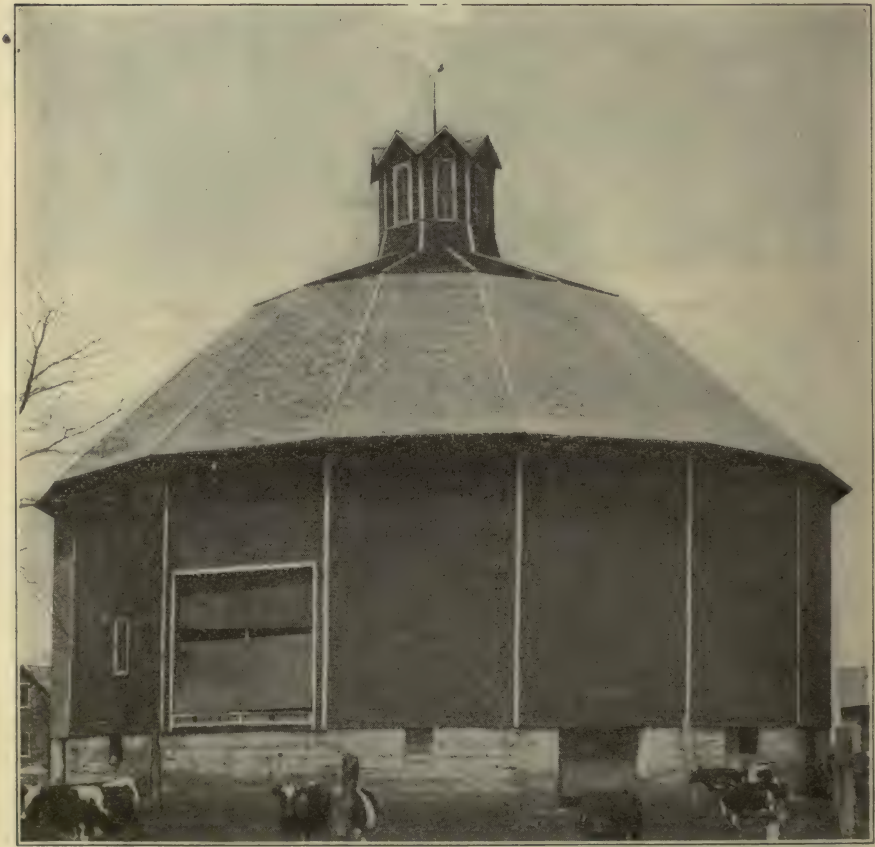

FIG. 41. BARN No. 6; 85 FEET IN DIAMETER; SAME SCALE AS DRAWING ON OPPOSITE PAGE.

Diameter, 85 feet.

Height, 26-foot posts on 9-foot wall.

Capacity, 88 cows; 350 tons of hay.

Foundation and first story, cement wall 9 feet above cement floor.

Supports, 4x8s, placed just back of stanchions, 3 feet on center.

Studs, 2x10s, 26 feet long, placed 2½ feet on center.

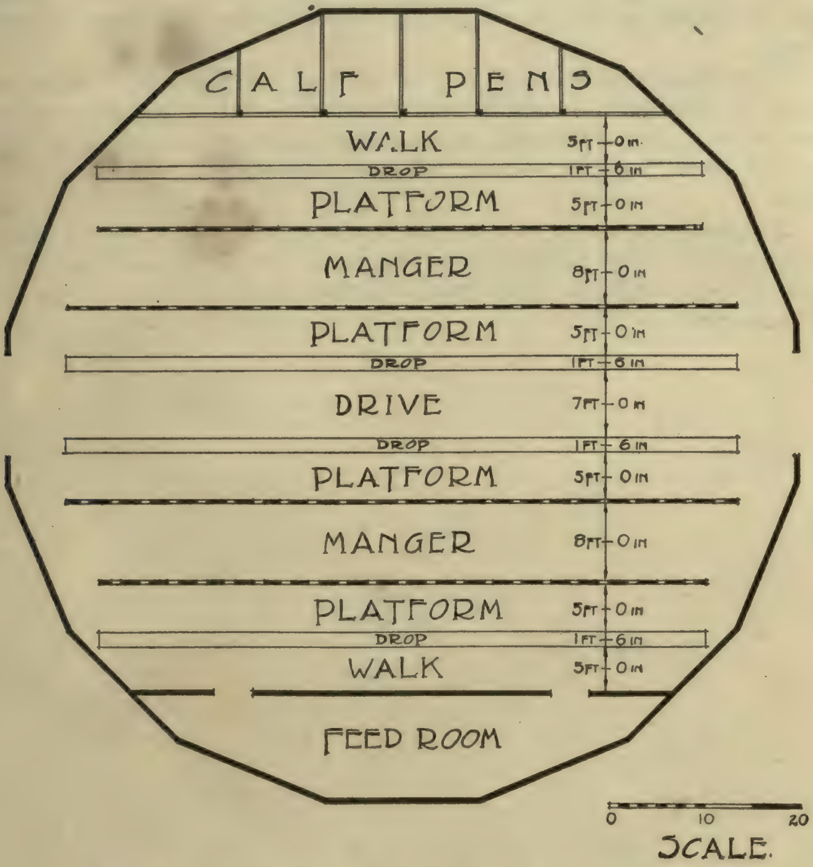

FIG. 42. ARRANGEMENT OF COW STABLE IN BARN NO. 6.

Joists 3x12s, 20 feet long, 14 inches on center for main span.

Rafters, self supporting. Sheathed with 1x6s with no space between. This roof has a purline plate thrown in the gambrel. The plate is supported only by the braces which tie the joints.

The barn has been racked three times by the wind, replumbed and heavy iron rods put in to brace it, yet it is out of plumb at the present time.

CONCLUSIONS

In summing up the data given in this bulletin, it is obvious that the advantages of the round barn are convenience, strength, and cheapness.

The round barn is the more convenient, because of the unobstructed mow, which reduces the labor required in mowing hay, and because of the greater ease and fewer steps with which the feed can be gotten to the cows, owing to the central location of the supply.

The circular construction is the strongest because advantage is taken of the lineal strength of the lumber. All exposed surfaces are circular, and withstand greater wind pressure, as the wind can get no direct hold, as on the sides or gable ends of a rectangular barn.

In round numbers, rectangular barns require, according to their construction, from 34 to 58 percent more in cost of material than round barns with the same floor area and built of the same grade of material.

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